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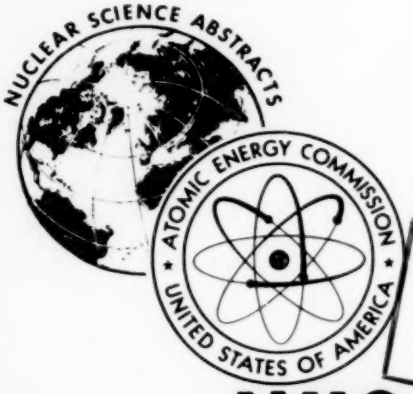

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NUCLEAR SCIENCE ABSTRACTS

Volume 17 Number 8

Abstracts 12055 – 13875

April 30, 1963

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Volume 17, Number 8, April 30, 1963

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Volume 17, Number 8 April 30, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

12055 (AD-277900) RADIOLOGICAL WARFARE. A Report Bibliography. Abbott Wainwright and John A. Baldwin, eds. (Armed Services Technical Information Agency, Arlington, Va.). July 1962. 125p.

A bibliography was prepared on the hazards and safety aspects of radiological warfare and nuclear explosions. Citations are included for reports cataloged by ASTIA from 1953 through June 1962, and are restricted to unclassified, unlimited references. References are arranged alphabetically by subject areas pertaining to blast effects, civil defense, fallout patterns and prediction, nuclear warfare, protection, radiation effects, radiation meters, radiobiological effects, sampling, thermal radiation and fire, and weapons. These subject areas are further subdivided into more specific topics. (auth)

12056 (BNL-742) ANNUAL REPORT, JULY 1, 1962. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 200p. (BNL-AS-16)

The research and development work is reported in sections on physical sciences and engineering, life sciences, and supporting activities. Separate abstracts were prepared for each of these sections. (J.R.D.)

12057 (BNL-742(p.1-85)) PHYSICAL SCIENCES AND ENGINEERING. (Brookhaven National Lab., Upton, N. Y.).

The research program in physics involves theoretical and experimental studies of fundamental properties of matter. Research activities at the cosmotron and AGS are summarized along with work on nuclear structure, neutron physics, and solid state physics. Other work is reported on instrumentation, chemistry related to radiations and nuclear properties, and applied mathematics. Work in nuclear engineering was devoted to fundamental studies in physics, chemistry, and metallurgy. Effort was also expended on studies of liquid metals, reactor materials, and diffusion of fission products in solids. (J.R.D.)

12058 (BNL-742(p.87-120)) LIFE SCIENCES. (Brookhaven National Lab., Upton, N. Y.).

Results of studies concerning the biological effects of radiation are reported. In general, problems are being investigated by methods of molecular biology. Progress is reported in sections on animal physiology, genetics, cell physiology, biochemistry, and biophysics. Activities in medical research aimed at increasing the knowledge of ionizing radiation effects on humans are reported. Some of the investigations are directed toward enhancing the beneficial applications of radiation, while others are directed toward diagnostic aspects. (J.R.D.)

12059 (BNL-742(p.121-45)) SUPPORTING ACTIVITIES. (Brookhaven National Lab., Upton, N. Y.).

The technical services and facilities essential to the research programs at the Laboratory are provided by organizational units which are described in sections on reactor operations, hot laboratory operations, health physics, mechanical engineering, machine shops, technical information, and photography. Other information is included on management operations. (J.R.D.)

12060 (NLCO-865) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1, 1962 TO DECEMBER 31, 1962. (National Lead Co. of Ohio, Cincinnati). Feb. 1, 1963. Contract AT(30-1)-1156. 52p.

Research progress is reported on uranous chloride as reducing agent for iron, computer solution for temperature distribution during bomb-reduction preheat, texture gradients in oil-quenched HAPO I and E fuel cores, corrosion studies of heat-treating rack materials, and comparison methods for particle size analysis. Separate abstracts were prepared for each topic. (M.C.G.)

12061 (NLCO-865(p.7-12)) URANOUS CHLORIDE AS A REDUCING AGENT FOR IRON IN SCRAP RECOVERY PLANT LEACH LIQUOR. J. H. Mueller, J. H. Cavendish, et al. (National Lead Co. of Ohio, Cincinnati).

Laboratory test results showed that the uranous (U^{4+}) chloride solution produced in the hydrochloric acid metal dissolver can be substituted for sodium thiosulfate as a reducing agent for the iron contained in Scrap Recovery Plant leach liquor. Estimated savings resulting from use of uranous chloride were calculated. (auth)

12062 (NLCO-865(p.13-30)) ANALOG COMPUTER SOLUTION FOR TEMPERATURE DISTRIBUTION DURING BOMB-REDUCTION PREHEAT PERIOD. R. L. Hodgson and J. H. Trapp (National Lead Co. of Ohio, Cincinnati).

By the use of an analog computer, radial temperature-time profiles were determined for the preheat period of the bomb reduction process. The effect on radial temperature-time profiles of liners and charges with different thermal properties was determined. (auth)

12063 (NLCO-865(p.31-6)) TEXTURE GRADIENTS IN OIL-QUENCHED HAPO I AND E FUEL CORES. C. A. Powell and N. K. Smith (National Lead Co. of Ohio, Cincinnati).

Four HAPO I and E uranium fuel cores, heated into the beta phase and oil-quenched, were examined for texture gradients in the longitudinal, tangential, and radial directions as functions of radial position. G_2, G_3, and J data are tabulated; and plots of G_3 values are presented. Additional

plots of G_3 are included which represent a statistical fit or best possible polynomial curve for the combined data from the four cores. (auth)

12064 (NLCO-865(p.37-42)) CORROSION STUDIES OF HEAT-TREATING RACK MATERIALS. P. M. Gribbell and T. R. Kato (National Lead Co. of Ohio, Cincinnati).

Cracking and corrosion of cast Hastelloy alloys and cast stainless steels in molten salt were investigated. Corrosion rates and cracking of heat-treating rack materials are discussed. (auth)

12065 (NLCO-865(p.43-51)) COMPARISON OF METHODS FOR PARTICLE SIZE ANALYSIS. J. A. Freitag (National Lead Co. of Ohio, Cincinnati).

A comparison was made of methods for particle size analysis as applied to uranium trioxide, uranium tetrafluoride, and magnesium fluoride. The methods studied were the Coulter counter method, sedimentation in liquid by the Andreason pipet and in nitrogen by the Micromerograph, and direct measurements from photomicrographs. Satisfactory agreement between the methods was observed for Winlo green salt. Disagreement was observed for uranium trioxide and magnesium fluoride with the most pronounced disagreement for the Micromerograph. The effect of particle shape and orientation is discussed as an explanation for the disagreement in results. (auth)

12066 (NP-12421) REPORT ON THE ACTIVITIES OF THE DANISH ATOMIC ENERGY COMMISSION, APRIL 1, 1961–MARCH 31, 1962. (Denmark. Atomenergikommissionen, Copenhagen). Oct. 1962. 84p.

Activities during the period are reported in chapters concerning construction, work of the research establishment, international co-operation in peaceful use of atomic energy, and administrative matters. Miscellaneous activities are also reported concerning geological surveys, education and information, and accelerator work. (J.R.D.)

12067 THE ROLE OF THE ARMY IN NATIONAL SURVIVAL. A. E. Wrinch (Canadian Army, Ottawa). Can. Med. Assoc. J., 87: 1146-53(Dec. 1, 1962).

Responsibilities of the Canadian Army in civil defense against nuclear attack are discussed. The responsibilities are: provision of technical facilities and operation of a system to give warning to the public of the likelihood and imminence of an attack; determination of the location of a nuclear explosion and the patterns of fallout, and warning of fallout to the public; assessment of damage and casualties from attack and fallout; control, direction, and carrying out of re-entry into areas damaged by a nuclear explosion or contaminated by serious radioactive fallout—decontamination work in those areas, and the rescue of and provision of first aid to those trapped or injured; direction of police and fire services in seriously damaged or contaminated areas, which are the object of re-entry operations; direction of municipal and other services for the maintenance and repair of water and sewer systems; provision of emergency support to provincial and municipal authorities in the maintenance of law and order and in dealing with panic or the breakdown of civilian authority; and maintenance and operation of emergency communication facilities. A nuclear detonation and fallout reporting system is described in detail. Fallout reporting posts are being located throughout populated areas, generally about 45 miles apart east and west, and 15 miles apart north and south. These posts are being located with existing installations of various Federal departments and other agencies. The system of fallout reporting posts will involve some 2000 stations throughout Canada. All are being equipped with radiation measuring equipment, also with extra equipment for about one-third of the posts to enable determination of the location of random bursts. (H.H.D.)

12068 ECHELONS OF MEDICAL CARE. W. S. Hacon (Emergency Health Services, Ottawa). Can. Med. Assoc. J., 87: 1153-6(Dec. 1, 1962).

Organization of the Canadian Emergency Health Services and its mobilization of medical facilities during a nuclear attack are outlined. It is estimated that a nuclear attack on Canada might reduce its medical and hospital care resources to about one-half by losses occurring in target cities. The remainder would be faced with an immense task of caring for casualties and in the absence of planning, it would be expected that nearly 20% of the casualties rescued would die because of inadequate medical care. Many more would remain disabled, but with planning, the mortality rate can be reduced. (P.C.H.)

12069 EMERGENCY HEALTH SUPPLIES: PRESENT STATUS OF PROCUREMENT AND CONTROL. J. Earle Matthews (Emergency Health Services, Ottawa). Can. Med. Assoc. J., 87: 1156-60(Dec. 1, 1962).

The scope of the Canadian Emergency Health Supplies Program for stockpiling drugs and medical equipment is discussed and its implementation described. In 1962, an $18,000,000 stockpile was authorized and purchases totaling $15,500,000 were made with deliveries to exceed $13,000,000. Over $6,000,000 worth of supplies was distributed to 8 regional depots across Canada in safe and strategic locations. Plans were made for release and control of supplies to provincial governments for use at all levels of control, and a Resources Planning Unit was organized. In Canada, undergraduate students in pharmacy receive special civil defence instruction in emergency health supplies service. (H.H.D.)

12070 RADIATION HAZARDS CONTROL IN SURVIVAL OPERATIONS IN THE EVENT OF A NUCLEAR WAR. Wilma G. Stewart (Defence Research Board Hdqs., Ottawa). Can. Med. Assoc. J., 87: 1173-7(Dec. 1, 1962).

Concepts of radiation protection in survival operations are explained, and procedures devised to control radiation hazards for the protection of the population and maintenance of the operating efficiency of survival operations personnel are presented. The major hazard is external exposure to penetrating gamma radiation. Radiation exposure guides are cited indicating that persons may be exposed to not more than 100-r whole-body radiation in a 6-week period, or 200-r whole-body radiation in a period in excess of 6 weeks, without loss of operational efficiency. Where exposures greatly exceed 200 r for the emergency period, additional exposures at operational levels will probably be followed later by appreciable damage to health. The rules are based on the need for preserving operational efficiency of a limited number of persons. For the general public, 25 r should probably be the upward limit. Beta radiation from fallout deposited on skin or clothing may produce burns, but the injuries will not be incapacitating and can be controlled by simple procedures. The internal hazard is mainly from ingestion of food or water contaminated with radioactive material. For protection, only canned or packaged foods and water from covered or deep wells should be consumed during the early days after a nuclear attack. (P.C.H.)

12071 REDUCTION OF FALLOUT RADIATION HAZARDS IN HEALTH INSTALLATIONS. W. R. Waters (Emergency Health Services, Ottawa). Can. Med. Assoc. J., 87: 1177-83(Dec. 1, 1962).

An estimation is made of fallout radiation doses expected to be received by hospitals in various target cities in Canada in event of thermonuclear war. The estimates are provided as guidance for Canadian hospital medical directors in planning protection for their patients and staff against gamma radiation. The implications of the distribution of fallout in Canada are such that the probability of exposures in excess of 600 r in the period 96 hr after fallout is high in Southern Ontario and Quebec but low in the western provinces and in the North. All hospitals should have a shielding capacity, which may entail structural alterations. The aim is to provide a protective factor of 100 or better, together with necessary standards of habitability. The engineering significance of the recommendations is discussed. The redesign and reconstruction of a 50-bed hospital to improve the protection factor are outlined in detail. The recommended changes would raise the protection factor to 100; where the critical 96-hr exposure in an unshielded locality would be 2500 r, hospital personnel and patients would be exposed to only 25 r. (P.C.H.)

12072 COLD INJURY IN CIVIL DISASTER. W. Zingg and J. A. Hildes (Univ. of Manitoba, Winnipeg, Can.). Can. Med. Assoc. J., 87: 1196-1200 (Dec. 1, 1962).

Consideration is given to the possibility of prolonged exposure to severe cold in event of nuclear attack on Canadian cities during the winter. Patients exposed to cold following a disaster may suffer from local cold injury or from systemic cold injury (accidental hypothermia). The treatment of the former is well established and consists of rapid rewarming of the frozen parts and physical therapy; early amputation is not advisable. Recommendations for the assessment and treatment of total-body cooling are not well established and are controversial. Since, at body temperatures below 30°C, death may be caused by cardiac arrhythmias and since, at this low level, spontaneous rewarming may not be possible, active rewarming is recommended at this stage. At a higher temperature level, vigorous warming is dangerous, and the patient's own regulatory mechanisms should be allowed to restore the temperature. (H.H.D.)

12073 UNITED STATES POLICY TOWARD THE INTERNATIONAL ATOMIC ENERGY AGENCY. HEARING BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SEVENTH CONGRESS, SECOND SESSION ON AUGUST 2, 1962. (United States. Congress. Joint Committee on Atomic Energy). 1962. 63p.

Hearings were held before the Joint Committee on Atomic Energy to determine U. S. policy toward the International Atomic Energy Agency. It was concluded from the hearings that the IAEA is the most effective means by which the U. S. can carry out the policy of furthering the utilization of atomic energy for peaceful purposes throughout the world. A detailed study will be made by the U. S. government of steps to be taken to further foreign policy objectives in the field of atomic power, and it will support actively the programs of the IAEA through financial support and technical advisory experts. (H.G.G.)

12074 THE CONTRIBUTION OF THE STATE TO THE GROWTH OF THE FRENCH ATOMIC INDUSTRY. M. Boulinier. Preprint S9-22. Prepublication Copy. 18p.

The French atomic energy commission (C.E.A.) was created in 1945 to prepare the country for the use of nuclear power. The principal aims of the C.E.A.'s industrial policy, the nature of the C.E.A. and its relation to the state and industry, and fundamental concepts which determine the relations between the C.E.A. and private industry are discussed. The "division of labor" between the C.E.A. and industry is described for such activities as design studies, heavy engineering, and production of U and other nuclear materials. The part played by the C.E.A. in foreign trade and in participation in foreign nuclear programs is also discussed. (M.P.G.)

BIOLOGY AND MEDICINE

General and Miscellaneous

12075 (DASA-1312) THE EFFECTS OF SHOCK TUBE GENERATED, STEP-RISING OVERPRESSURES ON GUINEA PIGS LOCATED IN SHALLOW CHAMBERS ORIENTED SIDE-ON AND END-ON TO THE INCIDENT SHOCK. Technical Progress Report. V. R. Clare, D. R. Richmond, V. C. Goldizen, C. C. Fischer, D. E. Pratt, C. S. Gaylord, and C. S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). May 31, 1962. Contract DA-49-146-XZ-055. 53p.

A total of 308 guinea pigs were exposed to air blast in 4 close-fitting, shallow, rectangular chambers mounted on the top, bottom, and sides of an air-driven shock tube. With a reflecting plate at the downstream edge of the chambers, the animals were exposed to "long"-duration, shock overpressures that initially rose in a single step. The LD_{50}-24-hr reflected pressure calculated from grouping all positions was 36.2 ± 0.8 psi. By moving the reflecting plate to various distances downstream of the chambers, shock overpressures that initially rose in two steps were applied. The results were that the animals' tolerances to overpressure rose as the time between pressure steps was increased. Comparison of the LD_{50}'s obtained with animals in each chamber revealed that there was not a significant statistica difference in their tolerances, whether they were "loaded" initially with the single-step pulse from their right, left, dorsal, or ventral surfaces. Animals that survived pressure-time conditions in the lethal range were considered as having been injured by the blast and were all pooled for 30-day serial sacrifice. It was found that the lung hemorrhage "cleaned up," and the lung weights returned to normal in 7 to 10 days as did the sub-mucosal hemorrhages in the stomach and intestines. The body-weight curve displayed an initial drop in 2 to 3 days, after which it rose to the starting level by the sixth day and then paralleled the controls. (auth)

12076 (DASA-1313) THE EXPOSURE OF GUINEA PIGS TO PRESSURE-PULSES GENERATED DURING THE END-TO-END TEST (NO. 2) OF ATLAS MISSILE 8-D (MARCH 31, 1962). Technical Progress Report. D. R. Richmond (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). June 26, 1962. Contract DA-49-146-XZ-055. 29p.

To help determine the extent of the blast hazard to the operator of a Pressure Control Unit, an Atlas 8-D missile was pressurized to 35 psi with gaseous nitrogen and ruptured with an explosive charge. Three guinea pigs were placed on the Pressure Control Unit which was located beneath the ramp 90 ft from the missile. In addition, ten guinea pigs were placed on the surface of the simulated ramp at 30-, 35-, 75-, and 94-ft ranges. Following the burst, missile fragments littered the test area, although none were found at the Pressure Control Unit. Overpressures of only 0.3 psi were recorded in the vicinity of the Pressure Control Unit. The pressure pulse was slow rising (9 to 14 msec) and endured for about 25 msec. The three guinea pigs at that location were unharmed. At the 30-ft ranges, pressures of 1.1 to 1.4 psi were recorded with times to peak and durations of 2 to 3 and 13 to 16 msec, respectively. One guinea pig's eardrum was ruptured, and one animal sustained a slight degree of lung hemorrhage. The other eight animals were unhurt. The biological results were discussed in relation to the pressure-time data. (auth)

12077 (DASA-1316) ORBITAL "BLOW-OUT" FRACTURES IN DOGS PRODUCED BY AIR BLAST. Formal Progress Report. D. R. Richmond, D. E. Pratt, and Clayton S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Apr. 10, 1962. Contract DA-49-146-XZ-055. 43p.

Eleven cases of orbital "blow-out" fractures involving 9 of 115 dogs that were subjected to shock tube-produced air blast are reported. Usually, there was failure of the frontal, palatine, sphenoid, and lacrimal bones, fragments of which were displaced medially and anteriorly into the nasal fossa with extension into the frontal and maxillary paranasal sinuses. In one instance there was extension into the cranial vault. Eye signs, in the form of proptosis of the globe, subconjunctival hemorrhage, ecchymotic areas of the globe and hemorrhage into the intra-orbital soft tissues, were found associated with all cases of orbital fracture. The pressure-time histories in which animals did or did not sustain orbital fractures are illustrated along with a tabulation of the corresponding pressure-time parameters. The data indicate that orbital fractures (caused by the eyeball and other intra-orbital tissues hydraulically transmitting the pressure-load to the walls of the orbit more rapidly than counter pressure developed in the air-containing areas bordering the orbit) occurred at maximal pressures above 140 psi provided they reached a peak in less than 30 msec. The incidence of "blow-out" fractures is discussed along with the significance of this lesion in relation to other blast-produced injuries. (auth)

12078 (DASA-1334) THE TOLERANCE OF GUINEA PIGS TO AIR BLAST WHEN MOUNTED IN SHALLOW, DEEP, AND DEEP-WITH-OFFSET CHAMBERS ON A SHOCK TUBE. Technical Progress Report. Donald R. Richmond, Victor R. Clare, and Clayton S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Oct. 27, 1962. Contract DA-49-146-XZ-055. 37p.

One hundred and eighteen guinea pigs were exposed to air blast in shallow, deep, and deep-with-offset chambers mounted on a shock tube. The LD_{50}-24 hours, in terms of the incident shock pressures measured adjacent to the chambers, was calculated by probit analysis to be 34.9 psi, 19.5 psi, and 26.8 psi for animals in the shallow, deep, and deep-with-offset chambers, respectively. According to the LD_{50} incident pressures, the shallow chambers offered the most protection against air blast; the deep chambers, the least. Comparing the LD_{50}-pressure "dose" at the animals' location revealed little difference in their tolerance to overpressure, per se; i.e., LD_{50} reflected pressures measured by gauges within the deep and deep-with-offset chambers were 34.6 psi and 35.9 psi, respectively. The LD_{50} incident shock pressure of 34.9 psi in the shallow chambers was considered to be the "dose" at the animal's location in that instance. The protection against blast provided by the three chambers and the response of animals to the particular pressure-time patterns encountered are discussed. (auth)

12079 (DASA-1335) A TENTATIVE ESTIMATION OF MAN'S TOLERANCE TO OVERPRESSURES FROM AIR BLAST. Technical Progress Report. Donald R. Richmond and Clayton S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 7, 1962. Contract DA-49-146-XZ-055. 51p.

Tentative estimates of the "sharp"-rising overpressures as a function of duration which represent a lethal hazard to

the 70-kg animal 1, 50, and 99% of the time were presented. The predictions were based on interspecies correlations and extrapolations encompassing blast-tolerance data for six mammalian species. The tentative application of the data to indicate human blast tolerance was discussed and relevant uncertainties in the estimates were emphasized. It was also pointed out that biologic tolerance would be different for air-blast pulses having non-ideal wave forms frequently associated with various geometries of exposure. Selected pathophysiological information pertinent to the biological response following blast exposure was given; namely, survival time and selected postshot observations of dogs and goats. (auth)

12080 (N62-11554) RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 1. Gilbert V. Levin, Harold G. Hedrick, John R. Clendenning, and Mary F. Thompson (Resources Research, Inc., Washington, D. C.). May 15, 1962. Contract NASr-10. 28p.

The biological phase of the work was concerned with literature reviews and laboratory activities, and information necessary to the development of a basic nonspecific microbiological medium was obtained. In the laboratory, the radioisotope techniques were established and preliminary experiments were performed. Various labeled compounds were incorporated into media. A number of species of bacteria were inoculated into portions of labeled medium, and the evolved gas was detected by its radioactivity. The design phase was concerned with instrumentation development. The device for obtaining soil samples from the target planet was refined. Experiments were carried out to select the radioactive gas fixing system and to study liquid and solid absorbers. The Geiger counter circuit was designed and components obtained. (auth)

12081 RADIOCALCIUM METABOLISM IN DISUSE OSTEOPOROSIS IN MAN. Robert P. Heaney (Creighton Univ., Omaha). Am. J. Med., 33: 188-200(Aug. 1962). (TID-16047)

Combined calcium balance and radioactive calcium turnover studies were performed in a series of normal and paralyzed adults. The purpose was to evaluate the kinetic factors responsible for disuse osteoporosis. Patients with acutely developing disuse osteoporosis were found to have bone formation rates from normal to twice normal and bone resorption rates from two to three times normal. The increased bone resorption rates more than accounted for the negative calcium balances of the subjects. Patients with chronic, stable (but severe) disuse osteoporosis were found to be in calcium equilibrium, with bone formation and resorption rates either normal or slightly low. The observations indicate clearly that the absence of mechanical stresses did not, of itself, reduce bone forming activity, and that a primary increase in bone resorption was responsible for the development of disuse osteoporosis. In vivo uptake measurements of Sr^{85} in one subject confirmed the kinetic observations, to the effect that a more severely paralyzed extremity took up more isotope than did its less severely involved mate. Measurement of gastrointestinal calcium absorption in all subjects studied revealed gross depression of absorption efficiency in the acute stage of osteoporosis. This change, together with elevations in both serum calcium and serum phosphorus, are interpreted as indications of suppression of endogenous parathyroid function. As such, the evidence precludes any possible role of parathyroid hormone in the genesis of disuse osteoporosis. (P.C.H.)

12082 THE BIOLOGICAL AND PHYSICAL ADVANTAGES AND PROBLEMS OF NEUTRON THERAPY. J. F. Fowler, R. L. Morgan, and C. A. P. Wood (Medical Research Council Cyclotron Unit, London). Brit. J. Radiol., 36: 77-80(Feb. 1963).

An a priori case for the re-examination of the possibility of using the fast neutron beam for the treatment of human cancer is presented. One of the outstanding problems of radiotherapy is that anoxic cells in a tumor are not killed as readily by x and γ rays as are well oxygenated healthy cells. However, it has been shown that the radiosensitivity of Ehrlich ascites tumor cells irradiated by fast neutrons is little affected by oxygen concentration, as compared with the much larger effect when irradiated with x rays. The relevance and importance of the oxygen effect to the radiotherapy of human cancer and possible ways to overcome it are discussed. (P.C.H.)

12083 PHYSICAL ASPECTS OF THE FAST NEUTRON BEAM. D. K. Bewley (Medical Research Council Cyclotron Unit., London). Brit. J. Radiol., 36: 81-8(Feb. 1963).

The design of the M.R.C. cyclotron chamber and irradiation room, with beam pipes and remote neutron target and external target for biological irradiations are given. Discussion is given on interaction of fast neutrons with matter and biological irradiations. Special attention is given to the dosimetry of the neutron beam with ionization chambers. (P.C.H.)

12084 RAPID SELECTION OF GROUP A RECIPIENTS AMONG MASS CASUALTIES. P. D. Stewart (Vale of Leven Hospital, Alexandria, Dunbartonshire, Eng.). Brit. Med. J., 2: 93-4(July 8, 1961).

A simple rapid way of typing potential recipients of group A blood is described. It would be useful in that the supply of blood would be almost doubled for transfusing mass casualties in the event of a thermonuclear war or other disaster. In addition to group O blood (47% of the population is group O), it would make available the large supply of group A blood (42% of the population) for transfusion in A and AB recipients. The test, which consists of adding a drop of blood and a drop of tap water to a slide coated with potent anti-A serum and watching for microscopic agglutination, was conducted on 278 persons under simulated emergency conditions. The results of the tests, carried out by persons with no laboratory experience and poor illumination, showed the possibility of serious errors in matching in only 0.3%. It was concluded that the risk would be justifiable under certain disaster conditions. (H.H.D.)

12085 MODIFICATION OF THE RADIATION CHARGE BY GRIDS AND OTHER FACTORS. W. Angerstein (Tuberkulose-Forschungsinstitut, Berlin). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 97: 780-4(Dec. 1962). (In German)

An account is given of the influence of grids on radiation dose and on the relative resolution of detail in the radiograph of the chest. The incident dose as well as the gonad dose (a phantom was used for the female gonads) were established for different grids with varied kilovoltage. Measurements were also made of the increase of the gonad dose with copper filters used in addition to a filtration of 2.5 mm Al equivalence. (auth)

12086 ADVANTAGES OF IODINE-125 FOR STUDYING THYROID FUNCTION IN EXPERIMENTAL ANIMALS. P. M. Daniel, Muriel M. Gale, and O. E. Pratt (Maudsley Hospital, London). Nature, 196: 1065-6(Dec. 15, 1962).

Merits of I^{125} and I^{131} as labeling agents in thyroid gland work are evaluated. Radiation dose comparison shows the I^{125} dose over a given short period to be about 12.3% of the dose from I^{131}. Half-lives and counting of the two are compared, and I^{125} is found promising, particularly for non-

survival experimental work in animals. I^{131} has displayed a tendency to leak from the thyroid. (D.C.W.)

12087 NEW DEVELOPMENTS IN RADIOLOGY. Fred J. Hodges (Univ. of Michigan, Ann Arbor). Postgrad. Med., 32: A55-9(Dec. 1962).

Various new procedures in radiodiagnosis and therapy are outlined with particular emphasis on their improvements over older methods in reducing radiation exposure to patient and radiologist. Image intensification and television monitoring of fluoroscopy represent 2 great advances in reducing exposure. Image resolution, automatic control of brightness, and relative simplicity of operation are now available; in addition, there is the potentiality of recording observations on video tape for replaying without the necessity for photographic development of film. The major advantages of television fluoroscopy are also given. Fluoroscopic image amplification enables carrying out fluoroscopy with extremely low levels of input radiation and consequent great reduction of incidental exposure to the operator. Other recent developments in this field are discussed, including kinescopic angiography, isotope scanning for tumor localization, whole-body counting for the detection of accidental ingestion of radioisotopes and following their elimination from the body, chemical radioprotective agents, and supervoltage radiotherapy for cancer. (P.C.H.)

12088 THE USE OF VITAL AND HEALTH STATISTICS FOR GENETIC AND RADIATION STUDIES. Proceedings of the Seminar, Held in Geneva, 5-9 September, 1960. United Nations Publication No. 61. XVII. 8. New York, United Nations, 1962. 270p. $7.50; 53/6 stg.; Sw. fr. 32.00.

Twenty-two articles are included: separate abstracts were prepared for 9; one article on medical findings and methodology of studies by the Atomic Bomb Casualty Commission on atomic bomb survivors in Hiroshima and Nagasaki was previously abstracted in NSA. The articles not abstracted include information on: potentiality of vital statistics for genetic studies; vital and population registration; certification and recording of morbidity and causes of death; use of routinely collected information for genetic purposes; information storage, retrieval, and processing; morbidity and genetic surveys; and biometrical genetics. (P.C.H.)

12089 CHANGING PATTERNS OF DISEASE AND THEIR IMPLICATIONS FOR VITAL STATISTICS AND GENETICS. J. V. Neel. p.1-9 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

The changing medical and sociological times and some of the alterations and innovations in the collection of vital and health statistics that may result are discussed. The nature of population genetics and some of the fields of interest to the geneticist in which the vital statistician could effectively help are reviewed. The study of consanguinity effects is mentioned as a powerful approach to determining the proportion of genes with undesirable effects, and the identification of consanguineous marriages could be made by entering the information in the civil registers. It is indicated that limited genetic registers, with a view to studying changes in mutation rates in conditions such as retinoblastoma, neurofibromatosis, and aniridia, might be broadened to study the effect of low-level exposure to radiation on the frequency of leukemia. The importance of follow-up studies on twins is also mentioned. (P.C.H.)

12090 INFORMATION SOUGHT ON SOMATIC EFFECTS. R. Doll. p.11-18 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

The range of somatic effects of radiation in man and the relation between dose and incidence are discussed. Four different ways by which vital and health statisticians can facilitate the work of the radiation epidemiologist are given. It is also suggested that there is a need for international agreement in the recording of the causes of stillbirth, in which the greatest interest would center around those that could be attributed to congenital malformation. (P.C.H.)

12091 THE CONTRIBUTION OF VITAL STATISTICS TO GENETIC AND RADIATION EPIDEMIOLOGY. W. P. D. Logan. p.23-5 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

Discussion is given on mortality statistics, which constitute both the background and the starting point for much epidemiological research. Difficulties encountered in obtaining vital statistics on morbidity with special emphasis on record linkage in England are given. One development under consideration is the construction of a population sample for a longitudinal morbidity study by linking birth and medical records. The possibility of follow-up studies of longitudinal cohorts of persons suffering from diseases such as cancer, and of individuals or families with required characteristics is also discussed. (P.C.H.)

12092 ASSESSING AND RECORDING HUMAN RADIATION EXPOSURE. B. Lindell. p.63-75 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

Basic information on the concept of radiation exposure is given. Discussion is presented on the necessity of a clear definition of the assumptions upon which an evaluation of effects at low doses of radiation may be made, with special emphasis on the common assumption that the effect is linear to the dose and that there is no threshold or recovery. The complexity of physical and biological parameters is pointed out, together with the difficulty of expressing the physical parameters in terms of some simple units. Several examples are formulated on the assumption of some specific dose-effect relations. A statistical measure of the usefulness of a given statistical material for studies of radiation effects was developed, and discussion is given on whether various studies can answer questions of dose-effect relations. (P.C.H.)

12093 FOLLOW-UP STUDIES OF BRITISH LUMINIZERS. J. T. Boyd. p.101-7 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

The preliminary stage of a follow-up of British luminizers was concerned with the tracing of former workers and bringing them forward for body measurement. The current status of a selected population of wartime workers was ascertained, and altogether contact was made with more than 600 ex-luminizers and some 350 were monitored for possible radium burdens. Breakdown of the measurement data by size of body burden and age at which workers commenced luminizing showed that the proportion of young workers increased steadily with the size of the burden from 60%, among luminizers with burden of less than 0.02 μC, to 90%, among luminizers in the highest burden range (0.05 μC and above). Other factors examined included year at which workers took up the occupation, duration of the occupation, and whether or not the operative ever used a brush and was potentially exposed to the hazard of pointing it with the lips. (P.C.H.)

12094 THE CHILD HEALTH SURVEY: A GENETIC STUDY IN JAPAN. W. J. Schull and J. V. Neel. p.171-93 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

Methods evolved for the Child Health Survey undertaken in Japan to evaluate the effects of inbreeding are described. The idea was to study all the available children (4,598) from consanguineous parents born in Hiroshima or Nagasaki in the years 1948-1953, and a corresponding control sample (4,784) born in the same cities and in the same years to unrelated parents. The procedure, from initial contact of the family, a subsequent home visit by a nurse, and finally an extensive half-day examination of each child at a clinic, is described in detail. This included a physical examination, psychometric appraisal, anthropometric data for growth evaluation, a thorough dental examination, a blood examination for parasitic and other infections, and a neurological work-up to assess motor development and mental retardation, if present. Some of the information collected by initial contactors and home visitors was verified with the help of a number of vital records available in the two cities. Also, the personnel used in the survey, together with the way in which they were selected and the instructions they were given to enable them to carry out their work, at the same time maintaining the harmonious public relations so necessary for the conduct of such a large-scale survey are described. (P.C.H.)

12095 AETIOLOGY OF CHILDHOOD MALIGNANCIES—CONGENITALLY DETERMINED LEUKAEMIAS. Alice Stewart. p.201-12 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

Data on childhood leukemias and other malignancies are presented and an hypothesis regarding their origins in relation to heredity and x-ray therapy are discussed. Use was made of death certificates for the ascertainment of cases and of the birth register for obtaining a matching control sample. The cases and control material were then followed up for a detailed family investigation by interview technique. Pathologists' reports were obtained for cases of leukemia and a comparison of the diagnosis entered on the death certificates and the one arrived at with the help of pathologists' reports is given. (P.C.H.)

12096 NATIONAL HEALTH SURVEYS AS A SOURCE OF MORBIDITY DATA FOR GENETIC AND RADIATION STUDIES. F. E. Linder. p.213-19 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

Methods evolved over a number of years for the U. S. Health Interview Survey and their utility in genetic and radiation studies are described. The questionnaire contains administrative and demographic items, items on illness, injury and impairment, hospitalization, medical and dental care, together with a number of probe questions on each item, to aid the memory. The sampling technique consists of classifying the whole country into about 400 homogeneous primary units, subdivided into 6000 segments, with six households in each. Some of the important factors affecting the precision of measurement in a survey of this type are listed and the error involved is indicated by means of the results of some of the pilot surveys conducted for this purpose. In a study to evaluate the usefulness of memory aids, it was found that the addition of a check list to probe questions almost doubled the amount of chronic illnesses reported. Another study demonstrated a decline in the reliability of information with an increase in the length of recall period. In short, the survey technique, developed to aid public health administration, is useful for evaluating relative changes rather than obtaining absolute measurements. The advantages and disadvantages of the survey methods for the evaluation of radiation hazards were considered and it was concluded that this type of survey has relatively little to offer to the investigators of genetic and somatic effects. (P.C.H.)

12097 EMPIRICAL STUDIES ON QUANTITATIVE HUMAN GENETICS. J. N. Spuhler. p.241-52 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

Data collected on assortative mating for body size and intelligence and total selection intensity due to differential fertility and mortality in human population are presented and their utility in studies on the quantitative genetics of human populations is discussed. The study on assortative mating included 43 body measurements and tests for intelligence on married couples, as well as data on their fertility. It revealed a positive assortative mating for 29 body measurements and for tested intelligence. The approach towards evaluating the effect of assortative mating on fertility, in order to determine its long-term genetic consequences, is described. The analysis revealed an absence of such an effect with respect to body measurements but a positive correlation between the tested intelligence of mothers and the reproductive performance. The study on the measurement of total selection intensity in various populations of the world and the components due to differential mortality and fertility was applied to 32 different populations. The results of the data and their genetic importance are discussed. (P.C.H.)

12098 METODIKA PRIMENENIYA RADIOAKTIVNYKH IZOTOPOV V BIOLOGII. (Application of Radio Isotopes in Biology). D. M. Grodzinskii. Kiev, Publishing House of the Ukrainian Academy of Agriculture, 1962. 171p.

Theoretical and practical problems in radioisotope application are analyzed, and methods of labeled in biology are discussed. Problems related to β and γ dosimetry are also discussed. (R.V.J.)

12099 THE EFFECT OF GAMMA AND NEUTRON RADIATION ON SOME CHEMICAL AND PHYSICAL PROPERTIES OF SOIL. David Gray Cummins. Thesis, Athens, Ga., Univ. of Georgia, 1962. 43p.

The effects of gamma and neutron radiation on the yield and nutrient uptake of rye grown on radiated soil, levels of nutrients in radiated soil, and the effects on cation exchange capacity, aggregation, particle size distribution, and moisture desorption properties of soil were studied. Cecil sandy loam and Lakeland sand were used. Yields of rye on Cecil and Lakeland soils were increased as a result of radiation. Yield increases were greater on Cecil soil than on Lakeland soil. Radiation increased the amount of nitrogen mineralized in the soil, which contributed to the increased yield of rye. The extractable P, K, Ca, Mg, and Na content of the soil did not appear to be affected by radiation. Radiation appeared to decrease aggregation in the Cecil soil. Fewer large aggregates were present in the radiated soil than in the untreated soil. Radiation did not appear to influence the cation exchange capacity, particle size distribution, or moisture desorption properties of either Cecil or Lakeland soil. (Dissertation Abstr., 23: No. 6, Dec. 1962)

Biochemistry, Nutrition, and Toxicology

12100 (TID-17541) CESIUM^{137} METABOLISM IN MAN. B. Rosoff, S. H. Cohn, and H. Spencer (New York Univ.,

New York; Goldwater Memorial Hospital, New York; Veterans Administration Hospital, Hines, Ill.; Brookhaven National Lab., Upton, N. Y.; and Montefiore Hospital, New York). [1962]. Contract AT(30-1)-1763. 23p.

The main pathway of Cs^{137} excretion in man following either intravenous or oral administration is via the kidney. The urinary to fecal ratio is approximately 10:1. Orally administered Cs^{137} is rapidly and almost completely absorbed. The metabolism of the radioisotope was shown to be similar following either intravenous or oral administration. Cs^{137} disappears very rapidly from plasma and is taken up by red blood cells. The biological half-life of cesium in man determined by analyses of excreta of two patients was found to be 50 and 60 days respectively. These values are similar to the biological half-lives obtained by long term whole-body counting studies. The distribution of Cs^{137} in man is fairly uniform in the soft tissues and the concentration decreases with time at different rates. Attempts to enhance the excretion rate of Cs^{137} with diuretics, corticosteroids, and ion exchange resins were unsuccessful. (auth)

12101 (JPRS-16900) SOVIET EXPERIMENTS WITH PLUTONIUM 239. A. V. Lebedinskii and Yu. I. Moskalev, eds. Translation of "Plutonii-239 Raspredelenie, Biologicheskoe Deistvie, i Uskorenie Vyvedeniya" (a publication of the State Medical Publishing House, Moscow, 1962). 87p.

Translations are presented of 5 articles of the Russian-language book, Plutonium-239 Distribution, Biological Activity, and Acceleration of Excretions. (C.H.)

12102 (JPRS-16900(p.9-22)) ACTION OF PLUTONIUM-239 ON THE RAT ORGANISM. Yu. I. Moskalev, L. A. Buldakov, and V. N. Strel'tsova. Translation of p.86-91 from "Plutonii-239 Raspredelenie, Biologicheskoe Deistvie, i Uskorenie Vyvedeniya."

The effects of Pu on the life span, weight, blood picture, and tumor development in rats were studied. The experiments were performed on 269 rats intravenously injected once with a solution of Pu^{239} at various dose levels. The animals were examined until death when autopsies were performed. The size of the dose had a definite effect on the life span, with deaths occurring 140 days after the injection of 5 μc/kg. The earliest changes were observed in the peripheral blood. Pathological findings are described. (C.H.)

12103 (JPRS-16900(p.23-47)) PATHOLOGICAL ANATOMY OF PLUTONIUM-239 SICKNESS. V. N. Strel'tsova. Translation of p.115-28 from "Plutonii-239 Raspredelenie, Biologicheskoe Deistvie, i Uskorenie Vyvedeniya."

A description is presented of morphological changes in dogs and rats during acute, subacute, and chronic poisoning by Pu^{239}. Acute Pu poisoning was characterized by manifestations of hemorrhagic diathesis, acute destructive changes in the hematopoietic system with subsequent signs of incipient regeneration of hematopoiesis, anemia, leukopenia, and changes in intestinal mucosa and liver parenchyma. Neoplasms of bony tissues and mammary glands developed in rats after doses of Pu that did not shorten the natural life span. (C.H.)

12104 (JPRS-16900(p.48-65)) PATTERN OF CHANGES IN THE BONY TISSUE OF RABBITS EXPOSED TO PLUTONIUM-239. Z. M. Bukhtoyarova. Translation of p.142-50 from "Plutonii-239 Raspredelenie, Biologicheskoe Deistvie, i Uskorenie Vyvedeniya."

Bony tumors developed in 51.5% of rabbits injected with 2 μc/kg of Pu^{239}. The morphological effects of various doses of Pu on the bony tissues of rabbits are described. All doses reduced the life span and resulted in marked changes in the peripheral blood picture. A comparison of the response of rabbits and rats to comparable doses of Pu^{239} revealed that rabbits are much more sensitive to this isotope. (C.H.)

12105 (JPRS-16900(p.66-74)) THE INFLUENCE OF ION-EXCHANGE RESINS AND COMPLEXONS ON THE DISTRIBUTION OF PLUTONIUM INTRODUCED INTO THE GASTROINTESTINAL TRACT. Yu. A. Belyaev. Translation of p.151-5 from "Plutonii-239 Raspredelenie, Biologicheskoe Deistvie, i Uskorenie Vyvedeniya."

Ion exchange resins were found to reduce the absorption of Pu from the intestine in rats when given by mouth. Best results were obtained when the resins were given immediately after the Pu. The resins also reduced deposition of Pu in the skeleton and liver. Intravenous injection of diethylenetriaminepentaacetic acid reduced the absorption and increased the excretion of Pu passing through the gastrointestinal tract. (C.H.)

12106 (JPRS-16900(p.75-86)) THE EFFECT OF CERTAIN COMPLEXONS ON REMOVAL OF PLUTONIUM FROM RATS. Yu. A. Belyaev. Translation of p.156-61 from "Plutonii-239 Raspredelenie, Biologicheskoe Deistvie, i Uskorenie Vyvedeniya."

The effectiveness of 5 complexing agents for removal of Pu from rats was investigated. Test results are tabulated for 1,2-diaminocyclohexanetetraacetic acid (DCTA), ethyletherdiaminotetraacetic acid (EEDTA), diethylenetriaminepentaacetic acid (DTPA), di-N-carboxymethylenediamino-bis-methylphosphinic acid (EDPA), and ethylenediaminetetraacetic acid (EDTA). The most effective agents tested were shown to be DTPA and EEDTA. The Pu content of both parenchymal organs and skeleton was reduced by both compounds. DTPA was more effective than EEDTA in acute experiments. (C.H.)

12107 STUDIES ON THE METABOLISM OF RADIOACTIVE STRONTIUM $Sr^{89,90}$. I. STUDIES ON THE EFFECTS OF AGE, DIET, AND VARIOUS CHEMICAL AGENTS UPON THE DISTRIBUTION OF $Sr^{89,90}$ IN ANIMALS. Kanji Torizuka (Kyoto Univ.). Acta Schol. Med. Univ. Kioto, 37: 108-25(Sept. 1960).

Studies were made on the effects of age, diet, EDTA, sodium citrate, zirconium citrate, calcium chloride, BAL, and parathyroid hormone upon the tissue distribution of Sr^{89} and Sr^{90}. In 40-day-old and 3- and 7-month-old male rats kept on a high or low Ca diet, an increase in excretion and decrease in retention of Sr were favored by increasing age and high-Ca diet. The increase in the amount of Sr excretion was due chiefly to urinary excretion. When EDTA, sodium citrate, and zirconium citrate were administered simultaneously with Sr, there was a statistically significant increase in the urinary excretion of Sr. On the other hand, calcium chloride, BAL, and parathyroid hormone had no effect on Sr metabolism. When EDTA, sodium citrate, and zirconium citrate were administered 4 days after the injection of Sr, an increase in the urinary excretion of the radioisotopes was observed during 24 hr following the injection of the isotopes. The augmentation of excretion caused by zirconium citrate was marked. The results show that elimination of Sr^{89} and Sr^{90} by various agents is greatly facilitated by early treatment, before the isotopes are incorporated in bone mineral. (P.C.H.)

12108 STUDIES ON THE METABOLISM OF RADIOACTIVE STRONTIUM $Sr^{89,90}$. II. STUDIES ON THE BINDING POTENCY OF Sr^{89} TO BONE TISSUE IN VITRO.

Kanji Torizuka (Kyoto Univ.). Acta Schol. Med. Univ. Kioto, 37: 126-38(Sept. 1960).

The dye bath method was used to study the binding of Sr^{89} to guinea pig bone slices (fresh bone and dead bone heated in distilled water at 100°C for 1 hr) to elucidate the mechanism of Sr^{89} deposition in the skeleton and the action of various chemical agents that remove Sr. When the slices were incubated at 37.0° in physiological saline solution or 1/5 M tris buffer solution (pH 7.24) containing $Sr^{89}Cl_2$, the binding rate of Sr with the slices could be expressed as an exponential function for 4 hr from the beginning of incubation. The binding rate of Sr and bone slices at 37.0° was higher than that at 27.4°, that is, the reaction is endothermic. Sr^{89} was first bound in the organic fraction and then migrated to the mineral fraction of bone tissue. EDTA and BAL prevented Sr binding to bone by forming chelate complexes with Sr. Zirconium citrate and calcium chloride acted by competition or an ion-exchange reaction with Sr in the organic fraction of bone tissue. Sodium citrate accelerated the excretion of Sr in vivo, but was not effective in preventing the binding of Sr to bone slices in vitro. The mechanism of these phenomena is not yet clear, but it may be concluded that the affinity of bone mineral for sodium citrate is greater than that for Sr. Parathyroid hormone had no effect on the binding of Sr^{89} by bone slices in vitro. (H.H.D.)

12109 MOBILIZATION OF CERIUM-144 AND LEAD-210 FROM THE TISSUES OF THE ORGANISM BY SUBSEQUENT USE OF DIETHYLENE TRIAMINOPENTAACETATE. D. I. Semenov and I. P. Tregubenko (Inst. of Biology, Academy of Sciences, Sverdlovsk USSR). Biochemistry (USSR) (English Transl.), 27: 271-4(Sept.-Oct. 1962).

The effects of a new complexone, diethylenetriaminopentaacetic acid (DTPA), on the mobilization of Ce^{144} and Pb^{210} by tissues in rats were studied. Prolonged use of DTPA raised the removal of Ce^{144} from the liver and skeleton of rats considerably. Also, there were actual differences in the degree of mobilization by the complexone of Ce from the tissues of male and female rats. The complexone DTPA was less effective in hastening the mobilization of Pb^{210} from the tissues. Increase in dose of complexone practically to the maximum (200 μ moles per rat daily for 10 days) gave no marked strengthening of mobilization of Pb from the tissues. (P.C.H.)

12110 PREPARATION AND MAINTENANCE OF THE PATIENT RECEIVING IRRADIATION FOR GYNECOLOGIC CANCER. William E. Crisp and John C. Ullery (Ohio State Univ., Columbus). CA, Med. J., 11: 88-91(May-June 1961).

Results of animal experiments and experience in irradiated humans are discussed from the viewpoint of protecting patients from the side-effects of radiotherapy, particularly individuals simultaneously debilitated by cancer. Animals in negative protein balance show a minimal adaptation response when exposed to irradiation and their tumors are relatively more radioresistant as compared with animals in positive nitrogen balance before therapy began. The radiation syndrome and its clinical manifestations are an additional stress to the cancer patient. Therefore, before therapy is started, the anorexia-malnutrition cycle prevalent in cancer must be corrected. This cycle can be broken by hyperalimentation with tube feeding, if necessary, with a caloric intake of 3500 calories a day and a minimum of 110 g of protein. The cancer patient needs ~3 times more protein than the normal intake to bolster the body's defenses. The importance of protein in preparing an animal to cope with the radiation stress is emphasized. Fat is also an important factor in making animals more resistant to radiation injury. All objective signs of infection in patients should also be controlled before therapy is started. In addition, prophylactic, broad spectrum antibiotics may be used. The incidence of radiation sickness is directly related to the psychological and physiological preparation of the patient for therapy. Since irradiation depresses the hemopoietic system, the blood profile must be followed closely during therapy. Close clinical observation is necessary to detect the warning symptoms and signs of impending complications. With high-voltage equipment in the treatment of gynecologic cancer, the gastrointestinal tract and genitourinary system are the most sensitive regions. (P.C.H.)

12111 DISTRIBUTION OF RADIOACTIVE SELENIUM IN MICE. G. B. Jones and K. O. Godwin (Univ. of Adelaide). Nature, 196: 1294-6(Dec. 29, 1962).

Organs from mice fed selenium, tagged with selenium-75, in lucerne grown in a solution containing $Na_2^{75}SeO_3$ are examined for concentrations of Se^{75}. Autoradiography reveals the greatest accumulation to be in the acinar tissue of the pancreas. Nursing mice are noted to exhibit radioactivity 4 hr after the dam has eaten the tagged lucerne, suggesting that Se is readily metabolized. Therefore, the pancreas as well as the kidney and liver may merit attention in Se metabolism studies. (D.C.W.)

12112 ON THE CONCENTRATION FACTORS OF SOME IMPORTANT RADIONUCLIDES IN THE MARINE FOOD ORGANISMS. R. Ichikawa. Nippon Suisan Gakkaishi, 27: No. 1, (1961). (In English)

The concentration of Sr, Cs, Mn, Zn, Fe, Co, and I was measured in numerous marine organisms that are consumed universally as food materials in Japan. These elements are of interest since they are commonly found as fission products or corrosion products in reactor coolants. (C.H.)

12113 METABOLISM OF RADIONUCLIDE IN FISH-II STRONTIUM–CALCIUM DISCRIMINATION IN GILL EXCRETION. R. Ichikawa, M. Oguri, and N. Fukuda. Nippon Suisan Gakkaishi, 27: No. 11, (1961). (In English)

Gill-perfusing experiments were carried out using the Japanese eel, Anguilla japonica, to investigate the behavior of Sr and Ca at gill excretion in fish. Calcium was shown to be more easily excreted than Sr. (C.H.)

12114 GILL ABSORPTION AND TISSUE DISTRIBUTION OF SOME RADIONUCLIDES. (Cr-51, Hg-203, Zn-65 and Ag-115m, 110), IN FISH. T. Hibiya and M. Oguri. Nippon Suisan Gakkaishi, 27: No. 11, (1961). (In English)

Absorption rate of some poisonous metals from the gill of fish was measured using the radioactive nuclides. The fish used was the Japanese eel, Anguilla japonica. Zinc, mercury, chromium, and silver were absorbed at the rate of 0.7 to 4.1×10^{-6}, 0.3 to 3.2×10^{-5}, 0.8 to 1.9×10^{-6}, and 1.2 to 4.2×10^{-7} mg per hour, respectively. Distribution and accumulation of the nuclides in goldfish body were investigated. The results obtained differed according to the kind of nuclide. Zinc, mercury, chromium, and silver are accumulated abundantly by the intestine, kidney, and liver, respectively. (auth)

12115 CONTRIBUTION TO THE STUDY OF CALCIUM METABOLISM CLINICALLY USING CALCIUM-47. PRELIMINARY NOTE. B. Delaloye, R. L. Tabau, and E. Lengyel (Universite Lausanne, Switzerland). Nucl. Med. 3: 51-62(1962). (In French)

Using an isotope technique described by Rich in the United States in 1961, Ca^{47} was administered by continuous intravenous infusion for two hours and recorded continuously the variations in concentration of the tracer in venous blood

samples. In this way it was possible to study the variations of the specific activity of the calcium and to obtain an indication of the size of the miscible calcium pool in the body. It was concluded that this method would be of practical interest to the study of calcium metabolism in clinical work. The study was concerned with cases of osteoporosis and osteomalacia before and after therapy with anabolic drugs and permitted observations to be made on the variations in the miscible calcium pool. (auth)

12116 INVESTIGATIONS ON THE QUESTION OF THE PASSAGE TO RAT FETUSES AND NEW BORN OF RADIOACTIVE COMPOUNDS USED IN THE DIAGNOSIS OF BRAIN TUMORS. I. PLACENTAL TRANSFER OF 6.4-DAY RADIOBISMUTH (Bi^{206}). F. Mundinger and R. Sander (Universität, Freiburg i. B.), Nucl. Med., 3: 63-81(1962). (In German)

In two series of a total of 70 pregnant rats and 870 fetuses and new-borns, the placental transfer to fetuses of the 6.4-day Bi^{206} which is used for the diagnosis of brain tumors, was investigated both qualitatively and quantitatively. The purpose of these studies was to estimate the dose which can be expected as a result of irradiation of human fetuses in various stages of their development if a Bi^{206} localization test is carried out during pregnancy. The following results were obtained. Bismuth is transferred through the placenta to the fetus. The concentration of bismuth in the fetus is considerably lower than that in the mother animal. If the average concentration in the mother animal is taken as 1, that in the fetus was maximally 109/1000 and that in the new-born 13/1000. There was no increased concentration of bismuth in embryonal tissue in contrast to tumor tissue. During bismuth transfer the placenta functions as "regulatory uptake" organ. Extrapolating these results obtained in animal experiments to the human situation by relating the bismuth fractions to the different weight ratio, a total maximum cumulative dose of 0.08 rep tissue of the fetus and the new-born would be obtained if the mother would retain 0.3 mC of the administered dose. The main contribution to the total dose, amounting to 0.84 rep, results however from radioactivity in the tissues of the mother. Although this radiation dose, according to our present knowledge, appears to be acceptable, localization tests with radio-bismuth should be carried out during pregnancy only under exceptional circumstances. (auth)

12117 REGENERATION OF TISSUES UNDER THE ACTION OF EXTRACTS IRRADIATED BY γ- AND X-RAYS. G. D. Tumanishvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 109-14(1962). (In Russian)

The action of injected irradiated (1000-r dose) and non-irradiated extracts of hen liver and frog liver on mitotic activity of regenerating liver of a frog was studied in partial hepatectomy. The extract of hen liver increased mitotic activity in a homologous organ. Frog liver extract increased mitotic activity only after it had been irradiated. The action of the irradiated hen liver extract on the growth of a twelve-day chick embryo was also studied. The phase of inhibition of growth was found. It suggests the existence of two factors in the extract where one is stimulating and the other is inhibiting. (auth)

Fallout and Ecology

Refer also to abstract 12071.

12118 RADIOACTIVE TUNGSTEN IN THE ATMOSPHERE. B. V. Kurchatov, V. N. Lavrenchik, and V. M. Shubko. At. Energ. (USSR), 13: 576-80(Dec. 1962). (In Russian)

Air activity measurements revealed the presence of new isotopes in the Eastern part of the Soviet Union beginning in June 1958; a few months later these isotopes, W^{181} and W^{185}, were found also in the atmosphere over the European part of the country. Spectrographic and β-counting techniques made it possible to determine the time of the formation of these isotopes. The γ energy of one of the isotopes was found to be 58 ± 1 kev and its half life about 140 days, indicating that it was W^{181}, forming Ta^{181} by electron capture. The maximum γ energy of 430 pointed to the presence of W^{185}. These calculations indicated that the presence of the W isotopes in the atmosphere is due to the U. S. thermonuclear bomb tests during May and June of 1958. The geographical distribution of the W isotopes coincides with that of the fission fragments but their residence time is much shorter; this is probably due to the weight and size of the aerosols on which the W settled. The concentration maxima showed the effect of quasistationary subtropical anticyclones. In the vertical direction, the lower layers, at about 17 km, were found to be most contaminated. The distribution data agree well with the values reported by L. Lockhart et al. (Science, 132: 831 (1960) No. 3420). (TTT)

12119 RADIOACTIVE FALLOUT. Brit. Med. J., 2: 1143-5(Oct. 28, 1961).

Consideration is given to radioactive fallout as a result of the resumption of nuclear weapons testing. Discussion is given on types and sources of radiation exposure from fallout, assessment of the hazard from fallout originating from earlier and recent tests, possible consequences of explosion of a 50-megaton bomb, and arrangements for monitoring and assessing the fallout situation. Measurements of I^{131} in milk recorded in various regions of the United Kingdom on October 1 and 15, 1961, are appended. (P.C.H.)

12120 SOME DETERMINATIONS OF Sr^{90} IN CUTTLEBONE (SEPIA BONE). E. Cerrai (CISE, Milan), L. Pelati, B. Schreiber, and C. Triulzi. Energia Nucl. (Milan), 10: 45-6(Jan. 1963). (In English)

Measurements were made of the Sr^{90} content of bones from cuttle-fish in the Adriatic and Ligurian Seas. The fish were collected during the period from November 1961 to May 1962. The bones were cleaned, ground, and heated. After the separation of the Sr–Ca content, the strontium was determined by flame photometry. The radioactivity was determined by counting with a low-background end-window beta counter. The specific activity of the samples from the Adriatic Sea was higher than that of samples from the Ligurian Sea. This was in agreement with the activity for Sr^{90} in the water of the two seas. (M.C.G.)

12121 SURVEY OF MEASUREMENTS OF RADIOACTIVE FALLOUT IN DENMARK. Medd. Sundhedsstyr., 108: 809-12(Sept. 22, 1961), Suppl. to Ugeskrift Laeger, 123: No. 38, (Sept. 22, 1961).

Fallout levels before and after the 1961 nuclear weapons tests are reported. (H.H.D.)

Radiation Effects on Living Tissues

12122 (BNL-6203) THE EFFECTS OF CHRONIC GAMMA IRRADIATION ON THE APICAL MERISTEM AND BUD FORMATION OF TAXUS MEDIA. J. P. Miksche, A. H. Sparrow, and Anne F. Rogers (Brookhaven National Lab., Upton, N. Y.). 1962. Contract AT-30-2-GEN-16. 21p.

Four-year-old plants of Taxus media cv. Hatfieldii were exposed to chronic gamma radiation from Co^{60} at daily dose rates of 2.5, 3.75, 7.5, 15, and 30 r per 20-hour day.

A dose response curve shows that dose rates as low as 3.75 r per day will reduce significantly the frequency of bud formation. At 12.5 r per day bud formation was reduced to 0.5% of the controls. Histological examination reveals that complete disorganization of the shoot apex occurs after an accumulation of 187.5 r at this low dose rate. Evidence for a pattern of differential sensitivity in the stem apex is presented. The decreasing order of radiosensitivity of the apical regions is: the apical initial layer, lateral initial layer, central mother-cell zone, transition zone, axillary cells and the pith meristem region. This pattern of radiation damage can be described as outer to inner, i.e., the outer cells are the first and the inmost cells are the last to show radiation damage. This response occurs at all dose rates studied above 2.5 r per day. A recovery mechanism frequently is observed at the lower dose rate (2.5 and 3.75 r per day) which leads to the occasional regeneration of a new operative apex from cells in or near the axillary regions. It is apparent from our data that T. media cv. Hatfieldii is one of the most radiosensitive of the higher plants yet studied. (auth)

12123 (BNL-6586) ABSCOPAL EFFECTS OF LOCALIZED IRRADIATION BY ACCELERATOR BEAMS. C. R. Jansen, V. P. Bond, K. R. Rai, and S. W. Lippincott (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT-30-2-GEN-16]. 30p.

The existence of abscopal effects of radiation, those in organs at a distance from the irradiated volume in mammals, was investigated. Swiss Albino mice were irradiated over portions of the abdomen with 20 Mev deuterons. The mean thymus and spleen weights in animals receiving abdominal irradiation were markedly depressed in comparison to controls and to animals receiving exposure to the back. The amount of suppression was much more pronounced in the thymus than in the spleen. It was found that by irradiating a larger volume or surface area, a more pronounced suppression can be brought about. (M.C.G.)

12124 (TID-15508) A SEX DIFFERENCE IN MOUSE SURVIVAL UNDER DAILY GAMMA IRRADIATION, AND ITS MODIFICATION BY GONADECTOMY. K. F. Hamilton, G. A. Sacher, and D. Grahn (Argonne National Lab., Ill.). Jan. 1962. Contract [W-31-109-Eng-38]. 13p. (UAC-6111)

At a daily dose of 145 r/day intact young adult male mice live 33 days, about 7 days longer than intact females. Gonadectomy moves both sexes toward an intermediate survival value and reduces the sex difference to less than 3 days. The effect of gonadectomy on body weight parallels the effect on survival. The mechanisms of these effects have not been identified. (auth)

12125 (TID-15755) THE EFFECT OF X-RAY IRRADIATION ON THE LIPIDS OF THE LIVER MITOCHONDRIA. H. P. Schwarz, L. Dreisbach, M. Barrionuevo, A. Kleschick, and I. Kostyk (Philadelphia General Hospital). [May 1962]. Contract AT(30-1)-1864. 10p.

The described accumulation of phosphatidyl glycerol in liver mitochondria of irradiated rats suggests a more prominent role of lipid changes in irradiation injury than has been considered up to now. The importance of these findings would be enhanced if future studies would show a definite metabolic relation between phosphatidyl glycerol and cardiolipins as is inferred by their identical fatty acid composition, as well as by enzymatic studies in vitro (8). Such a relationship might be of great interest, because of the probable role of such lipids in the electron transfer system suggested recently (9).

12126 (TID-15840) RADIATION EFFECTS OF CARBON-14 AND TRITIUM ON GROWTH OF SOYBEAN. W. Chorney, N. J. Scully, and H. J. Dutton (Argonne National Lab., Ill. and Department of Agriculture. Northern Utilization Research and Development Div., Peoria, Ill.). Apr. 1962. Contract [W-31-109-eng-38]. 24p. (UAC-6360)

Soybean plants (Chief variety) were labeled with C^{14} or H^3 by culturing them from seedling to mature stages in hermetically sealed plant growth chambers containing either tritiated water or radiocarbon dioxide environment. Plants cultured for approximately 90 days were uniformly labeled at 86.2 μc of C^{14} and 337.8 μc of H^3 per gram of carbon and hydrogen, respectively. Radiation dose levels in the harvested, mature air-dried seed were 106 and 228 rep per day for C^{14} and H^3, respectively. Plants grown from C^{14} seed developed a significantly greater number of visible main axis nodes than controls while plants from H^3 seed developed fewer. At harvest C^{14} and H^3 plants yielded significantly fewer pods and seed than controls. H^3 plants developed tumorous enlargements at the stem-tip regions; the youngest leaves exhibited yellow or white, chlorophyll-deficient, areas compared to normal green control leaves. Roots of C^{14} plants developed numerous nodule-like structures. In percent oil and in constituent fatty acid composition, the C^{14} and H^3 seed did not differ from the controls, notwithstanding the radiation-induced developmental anomalies associated with the see-parents. Early plantings of C^{14} and H^3 seed developed normal plants. After storage for 44 weeks both the C^{14} and the H^3 seed lots germinated but the former failed to survive. Seedlings from H^3 seed grew normally except for some leaf-pigment anomalies. (auth)

12127 (TID-15950) LEUKEMIA, SARCOMA AND RADIOACTIVITY. Shields Warren (New England Deaconess Hospital. Cancer Research Inst., Boston). [June 8, 1962]. Contract AT(30-1)-901. 13p.

Data are reviewed on the induction of leukemia, osteogenic sarcoma, thyroid cancer, and skin cancer by exposure to ionizing radiation. Available data on man are compared with experimental data from laboratory animals. The radiation danger from fallout for human populations is considered. (43 references.) (C.H.)

12128 (TID-16248) INFLUENCE OF DTPA THERAPY ON LONG-TERM EFFECTS OF RETAINED PLUTONIUM. Marcia W. Rosenthal, Joan F. Fried, Arthur Lindenbaum, and Jack Schubert (Argonne National Lab., Ill.). May 1962. Contract [W-31-109-eng-38]. 18p. (UAC-6449).

Daily injections of diethylenetriaminepentaacetic acid (DTPA), begun 3 days after administration of Pu^{239} to mice, were continued for 1 to 12 days. Significant increase in survival followed 8 or 12 days of DTPA. Twelve days of therapy removed 43.2% of the Pu from the bone by the end of the treatment period and reduced the fraction of mice with bone tumors by 42.5% at the time the last control had died. Two days of therapy had less effect on removal and tumor incidence. Bone tumor expectancy increased with time after the administration of Pu. (C.H.)

12129 (TID-16249) POSSIBLE ROLE OF CATALASE IN RADIATION EFFECTS ON MAMMALS. John F. Thomson (Argonne National Lab., Ill.). May 1962. Contract [W-31-109-eng-38]. 25p. (UAC-6452)

Results are reviewed from a number of studies on the role of catalase in the radiosensitivity of mammals. It is pointed out that most of the catalase in the body is associated with cytoplasmic particulates and the presence of catalase in the nuclei of cells is uncertain. Techniques used

to measure catalase activity in tissues are discussed. It is postulated that the role of catalase in the effect of radiation on the mammalian organism is negligible. (C.H.)

12130 (TID-17819) RaD (Pb^{210}) IN THE HUMAN SKELETON. ESTIMATES OF THE EXPONENT OF THE RETENTION FUNCTION, THE SKELETAL CONTENT AND THE DOSE RATE IN RADIUM BURDENED PEOPLE. Richard B. Holtzman (Argonne National Lab., Ill.). Nov. 1962. Contract [W-31-109-eng-38]. 9p. (UAC-7091)

Measurements were made of radiation dose from Pb^{210} in the human skeleton for 63 different subjects from 24 to 36 years after the administration of Ra^{226}. The analyses were made on 1 g bone samples obtained from autopsy. The bone was wet-ashed in nitric and perchloric acids and converted to 0.5 N hydrochloric acid. The Pb^{210} decay product, Po^{210}, was then plated onto a silver disk and α counted. $Radium^{226}$ was determined by the Rn emanation method. Calculations were made of terminal Ra^{226} body burdens and average skeletal dose rates. (C.H.)

12131 (TID-17820) NATURAL AIRBORNE RADIOACTIVITY RaD (Pb^{210}) AND RaF (Po^{210}) IN THE HUMAN BODY. Richard B. Holtzman (Argonne National Lab., Ill.). Nov. 1962. Contract [W-31-109-eng-38]. 14p. (UAC-7046)

The population of certain areas of Illinois has a high body content of Ra^{226} from high levels in the drinking water. The total skeletal dose rate of Pb^{210} and Po^{210} in this population was studied by analysis of bone samples obtained from surgery and autopsy. The concentration of Pb^{210} as a function of Ra^{226} was calculated. Possible sources of Pb^{210}, and the relative importance of each, were surveyed. Emphasis was placed on the contribution of natural airborne radioactivity to the total body dose. (C.H.)

12132 (TID-17840) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Annual Report, December 1961–December 1962. Jerome J. Freed and James L. Engle (Institute for Cancer Research, Philadelphia). Jan. 25, 1963. Contract AT(30-1)-2356. 21p.

The design, construction, and testing of a vibrating mirror flying spot microscope are described. This instrument is an ultraviolet microscope for use in protracted studies of living cells in terms of their ultraviolet absorption images. An extremely sensitive detector and image display via television techniques reduce the applied radiation dose to levels premitting survival of living cells for long periods of study. Applications in a number of cytochemical studies on living cells are described. (C.H.)

12133 (TID-17892) COMPARISON OF EMISSION FROM EXCITED STATES PRODUCED IN PROTEINS AND AMINO ACIDS BY ULTRAVIOLET LIGHT AND IONIZING RADIATION. Leroy Augenstein, James Carter, Jayanti Nag-Chaudhuri, DeVaughn Nelson, and Edward Yeargers (Michigan State Univ., East Lansing and Oak Ridge National Lab., Tenn.). [1963]. Contract [AT(11-1)-1155]. 34p.

Predictions about energy transfer events in biological preparations are usually made by extrapolating the patterns of ionization in gaseous systems. This technique seems inadequate to account for spectra of events in condensed systems. Therefore, a comparison of the emissions from powders of the aromatic amino acids and enzymes trypsin and ribonuclease resulting from x ray and ultraviolet light excitation is made. Experimental procedures are described, and the results are examined. Eventual appearance in the lowest excited level of some of the compounds of not less than 0.03 and 0.2 or more of the x ray energy absorbed is indicated. Ratios of fluorescence to phosphorescence are an order of magnitude greater during ultraviolet irradiation than during x irradiation. Emission and phosphorescence spectra, decay times, and intensities are displayed; and possible mechanisms for the phenomena observed are treated. 43 references. (D.C.W.)

12134 (FRL-TN-90) MAN AND RADIATION. Rudolf Schulze. Translated for Feltman Research Labs., Picatinny Arsenal, Dover, N. J. from Lichttechnik, 12: 443-8(1960). 20p. (AD-278083)

Material radiation, cosmic radiation, gamma radiation, and x radiation (which can ionize and thereby damage the cell albumin) appear in nature at such a low and constant rate that almost no biological effects are to be expected. The same is true for natural radioactivity. Added artificial radiation can, because of its concentration, become dangerous to the human organism. Natural ultraviolet radiation and visible light can reach man through the atmosphere practically without obstruction. Their intensity of radiation is high and fluctuating: with their biological effect very high, they can activate vitamins and enzymes, and they can influence the psyche favorably. (auth)

12135 (FTD-TT-62-1689) REACTIONS OF AN ORGANISM OCCURRING DURING MASSIVE γ-IRRADIATION. A. F. Bibikova, V. E. (Ye.) Busygin, Yu. G. Grigor'ev (Grigor'yev), T. V. Kalyaeva (Kalyayeva), R. M. Lubimova-Gerasimova (Lyubimova-Gerasimova), and A. B. Tsypin. Translated from Patol. Fiziol. i Eksperim. Terapiya, 6: No. 4, 57-62(1962). 15p.

Results of experiments are described in which a total of 60 rabbits were subjected to whole-body gamma irradiation for 60 min for a total dose of 30,000 r. The post-irradiation observations were centered around the brain. It was found that changes in brain hemodynamics are not accompanied by noticeable disorders of general hemodynamics. Death in the animals was caused by severe radioinduced disorders in the central nervous system. (J.R.D.)

12136 (JPRS-17161) LATE CHANGES IN THE OSSEOUS SYSTEM OF DOGS IN RADIOACTIVE STRONTIUM AFFECTION. N. N. Litvinov. Translated from Arkh. Patol., [24]: 23-8(1962). 7p.

Studies were made of bone tissue changes in 22 dogs who were given Sr^{90} and examined during the periods of 9 months to 6 years after the start of the experiment. In 10 dogs malignant bone tumors developed, in four leucosis was observed, and in three others cancer of the gum of the lower mandibula, agioma of the sexual organ, and cancer of the pancreas were diagnosed. During the latter stages of Sr^{90} affection, changes in the osseous system developed. The basic pathological processes are shown to be the dystrophic changes and the impairment of osteogenesis and normal reorganization of osseous tissue. (M.C.G.)

12137 THE OXIDATIVE PHOSPHORYLATION OF RADIATION-SENSITIVE ORGANS AFTER RADIATION EXPOSURE. H.-J. Altenbrunn and E. Kobbert. Acta Biol. Med. Ger., 9: 25-38(1962).

In isolated spleen or testicular mitochondria, held on ice for ½ to 3 hours, the oxidative phosphorylation (tested with succinate or alpha-ketoglutarate as substrates) was uncoupled; the P/O ratio dropped to about 60% of its original value. Cytochrome C or DPN did not prevent the drop or P/O during storage of mitochondria. Irradiation of mitochondria with doses of 10 to 14 kr (with 200 kv x rays) also did not affect the P/O ratio. Dinitrophenol uncoupled oxidation phosphorylation in irradiated or non-irradiated mitochondria to the same degree. (OTS)

12138 DETECTION AND SEPARATION OF SPONTANEOUS AND INDUCED TRANSLOCATIONS IN MATURE AND IMMATURE GERM CELLS OF DROSOPHILA. Mary L. Alexander (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Am. Naturalist, 96: 309-15(Sept.-Oct. 1962). (ORO-570)

Translocations of spontaneous origin were detected from unirradiated females in certain strains of D. virilis. Results for the spontaneous translocations were similar in appearance to the expected results if clusters of translocations were recovered from irradiated spermatogonia of males. Additional testing was necessary to separate spontaneous translocations originating in females from induced translocations in males. The method of separation is also applicable to separation of induced translocations of maternal and paternal origin when inseminated females are irradiated. Spontaneous translocations in females involved different chromosomes and therefore offer an evolutionary source of genetic variability of translocations. (P.C.H.)

12139 THE EFFECT OF X-RAY IRRADIATION ON THE AUTOLYSIS OF DESOXYRIBONUCLEIC AND RINONUCLEIC ACIDS OF THE BONE MARROW. G. A. Kritskii and Yu. T. Kovtun (Bakh Inst. of Biochemistry, Moscow). Biochemistry (USSR) (English Transl.), 27: 267-70(Sept.-Oct. 1962).

Methods used in the investigation of the autolysis of DNA are described, and results obtained in the investigation of the effect of irradiation on the process in the bone marrow of rabbits are given. It was found that the quantity of DNA that can be separated from irradiated bone marrow is higher by approximately 15% than that which can be separated from nonirradiated bone marrow. The DNA freed after irradiation because of loosening of its firm bond with protein is apparently subjected to increased autolysis. The incomplete autolysis of DNA is increased by a factor of more than 3 immediately after local irradiation with a dose of 2000 r, whereas the autolysis of RNA does not change. (P.C.H.)

12140 RADIATIONAL STUDY OF THE ROLL OF THE NUCLEUS IN THE INCREASE IN CYTOCHROME OXIDASE ACTIVITY IN FISH EMBRYOS. A. A. Neifakh and G. V. Dontsova (Inst. of Animal Morphology, Moscow). Biochemistry (USSR) (English Transl.), 27: 290-7(Sept.-Oct. 1962).

The role of the nucleus in changes taking place in the activity of cytochrome oxidase activity in fish embryos was studied. It was found that inactivation of nuclei by ionizing radiation had little effect on the subsequent rate of growth of cytochrome oxidase activity in the developing embryos when irradiation was effected within a period of time lasting from the 15th minute after fertilization to the midblastula stage (7 hr at 21°), or after the early gastrula stage (11 hr). Irradiation of the nuclei between the 7.5- and the 11-hr stages was followed by total abolition of increase of enzyme activity. The significance of the findings is discussed. Inactivation of the nuclei of the gametes, by their separate irradiation before fertilization, showed that both gametes, male and female, contributed an equal share to development of cytochrome oxidase activity, neither of them alone being adequate for assuring the normal increase. The nuclei of each of the gametes were able, when the nucleus of the second gamete was inactivated, to provide for more than half of the normal rate of increase of cytochrome oxidase activity. This function of the nuclei is achieved within the space of 2 to 4 min, between the 6th and the 11th minutes following fertilization (at 21°). A number of observations provided evidence that this nuclear function differs from the ordinary genetic function, since it is achieved within an exceedingly short space of time, and at a very early stage of embryonic development. The view is expressed that this function consists in the formation of mitochondrial primers, which then multiply in the cytoplasm. (P.C.H.)

12141 INFLUENCE OF RADIATION ON THE INCORPORATION OF RADIOACTIVITY IN DIFFERENT CELL CONSTITUENTS. S. B. Bhattacharjee, M. Sarkar, and N. N. Das Gupta (Saha Inst. of Nuclear Physics, Calcutta). Biochim. Biophys. Acta, 66: 123-31(Jan. 15, 1963). (In English)

The effect of radiation on the incorporation of P^{32} into cold trichloroacetic acid-soluble fraction, lipid, and nucleic acid was studied in Escherichia coli. The fraction of the total cells capable of giving rise to visible colonies after a dose of x rays was determined from the agar plating. It was observed that the process of colony formation was about four times as sensitive as the nucleic acid synthesis in E. coli. Incorporation of radioactivity in lipid and acid-soluble phosphate was even less sensitive to radiation than nucleic acid synthesis. It is suggested that radiation possibly breaks the DNA-enzyme complex, one such break resulting in the inhibition of cell division but in only a slight decrease in nucleic acid synthesis. This was considered to be the reason for the observed greater radiosensitivity of colony formation than that of nucleic acid synthesis. (auth)

12142 A COMPARISON OF FAST NEUTRONS AND X RAYS IN RELATION TO THE "OXYGEN EFFECT" IN EXPERIMENTAL TUMOURS IN RATS. R. H. Thomlinson (Medical Research Council Cyclotron Unit., London). Brit. J. Radiol., 36: 89-91(Feb. 1963).

Practically identical tumors, RIB transplanted in a pure inbred strain of rat, were irradiated with a variety of doses under conditions where the tumor was completely anoxic, where the tumor lay free and the rat breathed air, and where the rat breathed oxygen at 45 psf. The results indicated that the presence of 1 to 10% of cells in low concentrations of oxygen gives much less protection to the tumor as a whole when irradiated with fast neutrons than when irradiated with 250-kv x rays. (P.C.H.)

12143 COMPARISONS OF THE EFFECTS OF X RAYS AND CYCLOTRON NEUTRONS ON MOUSE ASCITES TUMOURS, MOUSE TESTIS AND CHICK EMBRYOS. S. Hornsey and G. Silini (Medical Research Council Cyclotron Unit, London). Brit. J. Radiol., 36: 92-7(Feb. 1963).

The biological effectiveness of cyclotron neutrons as compared with x irradiations was studied: oxygen enhancement ratios for fast neutrons and x rays were compared using survival of Ehrlich ascites tumor cells as a basis for judging the likelihood of improvements in the treatment of partially anoxic tumors; RBEs for different types of damage in different tissues and organs were measured in order to see whether they fell into a narrow range, which could be considered to be typical of the neutron beam, or whether the values differed for different biological end points; and some data were derived on the effects of fractionation. The oxygen enhancement ratio for killing ascites tumor cells was 1.9 with neutrons, whereas the ratio with 200-kv x rays was 3.1. The effectiveness of 250-kv x rays relative to 8-mv x rays was 1.2 for the killing of chick embryos. The effects of fractionated radiation doses are also discussed. (P.C.H.)

12144 COMPARISON BETWEEN THE OXYGEN ENHANCEMENT RATIOS FOR NEUTRONS AND X RAYS, AS OBSERVED WITH ESCHERICHIA COLI B. Tikvah Alper (Medical Research Council Cyclotron Unit, London). Brit. J. Radiol., 36: 97-101(Feb. 1963).

A comparison was made between the oxygen enhancement ratio, m, for fast neutron and x irradiation of E. coli under four different culture conditions. It was found that in spite of variation in dose and in RBE, with conditions of growth, the ratio m_x to m_n remained fairly constant. However, the results suggest that m_n might be higher for neutrons from the Van de Graaff generator than for those from a cyclotron. (P.C.H.)

12145 THE RBE OF FAST NEUTRONS IN PRODUCING INTESTINAL AND SKIN INJURY IN RATS. B. A. Turner and J. F. Fowler (Medical Research Council Cyclotron Unit, London). Brit. J. Radiol., 36: 101-6(Feb. 1963).

Investigations were made on: the leakage of I^{131}-HSA (labeled human serum albumin) through the intestinal wall of rats as a measure of gut damage; skin reactions in rats in order to compare with skin reactions in pigs; and the slowing up of the passage of a barium meal through the stomach in rats, as an analog to radiation sickness. Doses less than 550 rads of x rays or 150 rads of fast neutrons gave rise to no increase in the leakage of I^{131}-labeled protein through the intestinal wall. However, at higher doses the difference in excretion between irradiated and control groups increased rapidly. The RBE of fast neutrons in damaging rat skin was found to be between 2 and 3. The mean value of RBEs for fast neutron and x ray radiation sickness in rats was 2.9 ± 0.35 standard deviations. (P.C.H.)

12146 EXPERIMENTS ON THE SKIN OF PIGS WITH FAST NEUTRONS AND 8 MV X RAYS, INCLUDING SOME EFFECTS OF DOSE FRACTIONATION. D. K. Bewley (Medical Research Council Cyclotron Unit, London), J. F. Fowler, R. L. Morgan, J. A. Silvester, B. A. Turner, and R. H. Thomlinson. Brit. J. Radiol., 36: 107-15(Feb. 1963).

A brief summary is given on treatment of patients with fast neutron beams and the effects on the skin. In attempts to determine skin damage by fast neutron and x irradiation, pigs were given doses sufficient to produce a moist or dry desquamation, which would heal within a reasonably short time. The skin damage was in the range of moderate to severe as judged by ordinary clinical experience. No significant difference in quality or degree of reaction was observed between the damage produced by fast neutrons and x rays. Subcutaneous damage appeared to correlate well with surface damage at periods of two or more months after irradiation. However, it was found that the RBE for a dose of neutrons fractionated into 6 fractions over 17 days is 3.3 ± 0.3 compared with a value of 2.5 ± 0.3 for a single dose. The RBE for 6 fractions, therefore, appears to be greater than that for single doses in the ratio of about 1.3 to 1. (P.C.H.)

12147 GENERAL REVIEW. J. F. Fowler and R. L. Morgan (Medical Research Council Cyclotron Unit, London). Brit. J. Radiol., 36: 115-21(Feb. 1963).

A review is given on radiation effects on long-term injury to normal tissues, hazards of damage to other tissues, and the advantage due to the reduced oxygen enhancement ratio. It was concluded that the main advantage of fast neutrons is the reduced oxygen enhancement effect, which enables anoxic tumor cells to be killed more readily than with gamma and x rays. The disadvantage of long-term skin damage is explained in terms of an increase of RBE with extended neutron fractionation. RBEs for a number of biological systems were between 2.5 and 3.0 for x-ray doses greater than 1000 rads, but appreciably higher for systems requiring lower doses and for anoxic tissues. (P.C.H.)

12148 EFFECT OF THE PRELIMINARY ADMINISTRATION OF RADIOACTIVE ISOTOPES ON THE COMPOSITION OF PERIPHERAL BLOOD AND THE SURVIVAL OF ANIMALS SUBSEQUENTLY X-IRRADIATED WITH A LETHAL DOSE. P. I. Lomonos. Byul. Eksperim. Biol. i Med., 53: No. 2, 79-82(1962).

The administration of radioactive isotopes prior to irradiation with lethal doses in order to increase survival rate, was studied. The experiments were carried out on albino rats (180 to 200 g) and albino mice (20 to 25 g). The animals received I^{131}, P^{32}, and methionine-S^{35} prior to x irradiation. The rats were irradiated with 800 r and the mice with 600 r, which corresponded to $LD_{60/30}$. The time interval between administration of the radioisotopes and subsequent irradiation varied according to the greatest functional changes observed in various functional systems. The administration of the radioisotopes 15, 45, and 55 days prior to a whole-body x irradiation of rats increased their survival rate by 5 to 23%. The effect of the administration of methionine was greater the longer the time-interval between its administration and the subsequent irradiation. Administration of methionine in mice 15 days prior to irradiation eliminated the radiation injury caused by 600 r. Methionine also had a good effect on the blood picture; the number of WBC, especially of netrophiles and eosinophiles, increased. (P.C.H.)

12149 EFFECT OF X-RAY IRRADIATION ON THE NON-CONDITIONED AND CONDITIONED REFLEX REACTIONS OF LEUKOCYTES. M. I. Ul'yanov. Byul. Eksperim. Biol. i Med., 53: No. 5, 63-8(1962).

Chronic experiments were carried out on 6 dogs. 1016 blood examinations were performed in 140 experiments (89 before and 51 after whole-body x irradiation). The irradiation doses were: 600 r at 9.5 r/min, 50 r at 2 r/min, and 3 r at 0.1 r/min. The conditioned reflex leukocyte reaction was attained by a cutaneous electrical stimulus. Clinical observations were continued after irradiation. The leukocyte reactions were studied for a long time, beginning with the first hours after irradiation. Stimulation of irradiated dogs brought about leukopenia after a dose of 600 r. After doses of 50 r functional reflex disorders preceded morphological changes while after a dose of 3 r no morphological changes appeared although reflex malfunction was noticed. The sensitivity of functional tests revealed radiation injuries in the blood not detectable morphologically. (P.C.H.)

12150 EFFECT OF IONIZING RADIATION ON IMMUNITY. Milton H. Brown (Univ. of Toronto). Can. Med. Assoc. J., 87: 1183-6(Dec. 1, 1962).

A literature review was made on the effects of radiation on immunity. It was concluded that near-lethal amounts of ionizing radiation administered to the entire body decrease host immunity to normal bacterial inhabitants of the gastrointestinal tract, skin, and respiratory system and to specific infections, and lowers antibody formation, especially to a primary stimulation. Treatment of infection following irradiation should be continued long enough for recovery of the immune mechanism to take place, which may be a matter of weeks. Active immunization should be carried out well in advance of exposure to ionizing radiation. Passive immunity may also be adversely affected, but this may be overcome by giving larger doses of antisera. Small amounts of x rays administered locally enhance antibody formation and resistance of experimental animals to certain infections. (P.C.H.)

12151 CUTANEOUS RADIOVACCINATION OF THE RABBIT. Jean Loiseleur, Liliane Catinot, and Annick de Vomécourt. Compt. Rend., 255: 2676-7(Nov. 12, 1962). (In French)

Irradiation, at an interval of some days, of several different cutaneous fields causes, in the rabbit, the restoration of the radiolesions subsequent to each of these irra-

diations. This restoration is shown after the second irradiation and becomes more and more rapid when the number of irradiated regions, which mark the steps of radiovaccination, increases. (tr-auth)

12152 EFFECTS OF RADIOACTIVE PHOSPHORUS ON THE GROWTH AND YIELD OF LUCERNE (ALFALFA). D. M. Guseinov and F. G. Isallva (Inst. of Soil and Agronomy, Academy of Sciences, USSR). Dokl. Akad. Nauk Azerb. SSR, 18: No. 7, 37-40(1962). (In Russian)

Applications of radioactive phosphor to blooming lucerne (alfalfa) in the form of KH_2PO_4 (85, 170, 340, and 1000 μc per 10 kg) resulted in better yield and faster plant growth. Combined P^{32} with HPB gave better yield than separate applications. Small additions of P^{32} also resulted in higher percentages of nitrogen and vitamin C in the hay. (R.V.J.)

12153 RADIATION PNEUMONIA. George C. Leiner and Hans R. Sielman. Expti. Med. Surg., 20: 75-85(Mar.-June 1962).

Two cases of radioinduced pneumonia, which occurred in women undergoing x-ray therapy for breast cancer, are described. The daily thoracic dose of 190-kv x rays was 210 r in both cases and the total doses were 2100 r in one case and 3350 r in the other. Symptoms of the developing radiation pneumonia simulated those of tuberculosis, including chest pains, dyspnea, and cough. Moreover, chest roentgenograms showed nodular infiltrations throughout both lungs, which were initially thought to represent tubercles. Fever was present in both patients and one patient developed pericardial effusion, possibly also attributable to irradiation. In 3 to 4 months, during which antibiotic and prednisone therapy was instituted, the pulmonary lesions cleared, apparently without development of fibrosis. (H.H.D.)

12154 FERTILITY STUDIES OF X-IRRADIATED MALE MICE. M. Maqsood and J. K. Ashikawa (Univ. of California, Berkeley). Fertility Sterility, 12: 452-8(Sept.-Oct. 1961).

Whole-body x irradiation of male Swiss mice at a single exposure of 625 r ($LD_{50/30}$) decreased the fertility rate and significantly lowered the number of progeny in litters obtained by mating x irradiated males with nonirradiated females 1 to 45 days after irradiation. At this dose level, x-irradiated males recovered in their fertility rate, as judged from their litter size production, 60 to 75 days postirradiation. Intraperitoneal administration of 1 ml olive oil within an hour after whole-body x irradiation improved the fertility 30 days postirradiation. The olive oil-treated mice were twice as fertile as the untreated x irradiated male mice. Litter size from matings of treated and untreated x irradiated male mice did not differ. Postirradiation olive oil treatment appears to accelerate rate of recovery by stimulating regenerative processes in x-irradiated males. (H.H.D.)

12155 CHARACTERISTICS OF RADIATION MUTATIONS IN SPRING WHEAT AS A FUNCTION OF THE TYPE OF RADIATION USED. P. K. Shkvarnikov and I. V. Chernyi (Inst. of Cytology and Genetics, Siberian Branch Academy of Sciences, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, 100-10(1962). (In Russian)

As was indicated in earlier publications (Radiobiologiya 1, 296 and 799 (1961)), the frequency and the nature of the radiation-induced mutations depend greatly on the type and dose of the mutagenic agent and on the species of the plant. In experiments with 4 varieties of wheat, it was found that γ radiation yields the highest number of desirable mutations, followed by thermal neutrons and x radiation. The optimum irradiation levels were 1000 to 15,000 r for γ rays, 1000 to 10,000 r for x rays, and 1×10^{10} to 4×10^{11} n/cm^2 for thermal neutrons. Of the 18 desirable features obtained, the most important were resistance to beating down, early maturity, and higher productivity. Gamma radiation is considered to be the most effective mutagenic factor, followed by thermal neutron flux. (TTT)

12156 RADIATION AS ONE OF THE POSSIBLE CAUSES OF CANCER. Yu. Ya. Kerkis (Inst. of Cytology and Genetics, Siberian Branch Academy of Sciences, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 10, 125-38(1962). (In Russian)

The connection between cell mutations, and therefore cancer, and ionizing radiation is pointed out and documented by references. Both low-level exposures, such as small doses received in medical and industrial exposures and those arising from fallout, nuclear accidents, and atomic explosions are reviewed. Attention is given also to the effect of chemicals as one of the causes of cell mutations. (108 references.) (TTT)

12157 T1 BACTERIOPHAGE PRODUCTION IN ESCHERICHIA COLI. Rose R. Feiner and Solon A. Ellison (Columbia Univ., New York). J. Bacteriol., 85: 7-11(Jan. 1963).

Progeny released from complexes formed between unirradiated Escherichia coli strain Bs-1 and ultraviolet (uv)-irradiated phage T1 were equally infective for strains B and Bs-1, and were therefore not host-modified. The capacity of Bs-1 for unirradiated or irradiated T1 is relatively insensitive to uv irradiation, as compared with that of strains B and B/r. In all three strains of E. coli, B, B/r, and Bs-1, the uv sensitivity of the capacity for phage T1 is independent of the uv sensitivity of colony-forming ability. These findings are discussed in relation to the partial genetic homology hypothesis. (auth)

12158 SOME MOLECULAR CHARACTERISTICS OF ERYTHROPOIETIN FROM DIFFERENT SOURCES DETERMINED BY INACTIVATION BY IONIZING RADIATION. Wendell F. Rosse, Roger J. Berry, and Thomas A. Waldmann (National Cancer Inst., Bethesda, Md.). J. Clin. Invest., 42: 124-9(Jan. 1963).

A crude, urine-derived, erythropoietin-containing preparation was subjected to inactivation by high-energy electrons and low-energy x rays. The molecular weight was calculated to be about 27,000 by use of target theory computations. Inactivation characteristics to low-energy x rays suggest that the molecule is asymmetric and is about 10 times as long as it is wide. The result of irradiation of erythropoiesis-stimulating material from renal and cerebellar hemangioblastoma cysts from patients with polycythemia suggests that the biologically active molecule from these sources has the same or nearly the same size as that derived from urine of an anemic patient. (P.C.H.)

12159 A REVIEW OF THE BIOLOGIC EFFECTS OF RADIATION. P. C. Johnson, Jr. (Baylor Univ., Houston, Tex.). J. Oklahoma State Med. Assoc., 54: 276-9(May 1961).

Effects of radiation on humans and animals are reviewed, particularly for physicians. (H.H.D.)

12160 EFFECT OF X-IRRADIATION ON THE DEGENERATION AND REGENERATION OF PERIPHERAL NERVES. N. K. Akhmedov. Med. Zh. Uzbekistana, No. 5, 11-13(1962).

The effect of x irradiation on the degeneration and regeneration of peripheral nerves was studied. 61 adult rabbits were used, 36 of which were irradiated for 4 days with a

daily dose of 300 r applied to the middle part of the left thigh. Seven days later about 0.5 cm of the left sciatic nerve was resected. The animals were watched constantly for 6 months and several were killed after various periods. The central and peripheral segments of the sciatic nerve and the tibial and peroneal nerves were examined histologically. 25 control unirradiated rabbits were otherwise treated in an identical manner. The results showed that regenerative processes commenced in the nerve of the irradiated animal relatively late, lasting longer than in the control. Irradiation also considerably inhibited the process of degeneration of the axons and resorption of the decomposition products in the injured nerve. (P.C.H.)

12161 THE INCORPORATION OF RADIOINDICATORS INTO NUCLEIC ACIDS AND PROTEINS OF IRRADIATED MICE. D. M. Abdurasulov, A. I. Nikolayev, and N. R. Oster. Med. Zh. Uzbekistana, No. 6, 22-4(1962).

Experiments were carried out on albino mice weighing 18 to 20 g and the rate of biosynthesis of proteins and nucleic acids was determined by the incorporation of P^{32}, C^{14}-glycine, and S^{35}-methionine. The animals were irradiated with 500 r and the labeled substances were injected 1, 24, and 100 hours after irradiation. (P^{32} – 0.45 μC/g b.w.; C^{14}-glycine and S^{35}-methionine – 0.2 μC/g b.w. each). The blood serum proteins were unaltered in all cases. No correlation between the protein synthesis and that of nucleic acids could be established. (P.C.H.)

12162 EFFECT OF X-RAY IRRADIATION UPON THE CONTENT OF GLYCOGEN AND REDUCING COMPOUNDS IN YEASTS. R. D. Gal'tsova and I. P. Vakina. Mikrobiologiya, 31: 577-81(1962).

Sacch. cerevisiae, Sacch. Frohberg carlsbergiensis, and Sacch. carslbergensis 10-D were x irradiated with 10 to 200 C at a dose rate of 800 r/min in pressed and sterile conditions, and grown on agar for 24, 48, 72, and 96 hr. Non-irradiated cells were grown under similar conditions. A very large inoculum was used. The glycogen content in the irradiated cells decreased (from 60 to 90%) in all three strains. Immediately after irradiation the glycogen content decreased only 5 to 8%. An average increase of 30 to 35% in the content of reducing compounds was observed in the irradiated and grown yeast cells. This increase was found also in cells immediately after irradiation with 20 to 25 C. Irradiation with 200 C resulted in an increase in reducing compounds by about 50% as compared with controls. (P.C.H.)

12163 SENSITIZATION OF RADIO-RESISTANT BACTERIA TO X-RAYS BY IODOACETAMIDE. C. J. Dean and P. Alexander (Chester Beatty Research Inst., London). Nature, 196: 1324-6(Dec. 29, 1962).

Bacteria suspended in a buffered solution containing Iodoacetamide are rendered more sensitive to x rays. Pseudomonas fluorescens, E. coli B/r, Micrococcus sodonensis, and Micrococcus radiodurans require smaller lethal doses when irradiated in the presence of Iodoacetamide. Bleaching the yellow pigment in Micrococcus sodonensis and reduction in the oxidation of pyruvate by this organism are also noted. (D.C.W.)

12164 INFLUENCE OF X-RAYS ON THE INCORPORATION OF DEOXYRIBONUCLEIC ACID PRECURSORS INTO SOME MAMMALIAN CELLS IN VITRO. J. Jasinska and A. Michalowski (Inst. of Oncology, Warsaw). Nature, 196: 1326(Dec. 29, 1962).

The relation between the dose of x rays and the depression of thymidine incorporation in anoxic suspensions of rat bone marrow and Ehrlich ascites tumor is examined. The same dose-response curves for incorporation of thymidine are noted. The environment of the cell is thought to account for the lack of specificity of x ray action on thymidine incorporation. Curves for dose response of DNA precursor incorporation into human bone marrow and Ehrlich ascites carcinoma have a striking similarity. (D.C.W.)

12165 RESTORATION OF X-IRRADIATED L-CELLS BY MEANS OF HIGHLY POLYMERIZED ISOLOGOUS DEOXYRIBONUCLEIC ACID. B. Miletić, D. Petrović, and Lj. Zajec (Ruder Bošković Inst., Zagreb). Nature, 197: 90-1(Jan. 5, 1963).

Addition of highly polymerized isologous DNA to irradiated cultures of L-cells has a notably restorative effect. The degree of restoration is almost the same regardless of the amount added, but marked variation in restoration has been noted for DNA samples from the same source. (D.C.W.)

12166 RADIOINDUCED TURGOR MOVEMENTS (RADIONASTY) IN MIMOSAS AND OTHER SENSITIVE PLANTS. O. Hug and H. Miltenburger (Universität, Munich and Gesellschaft für Kernforschung, Nuremburg). Naturwissenschaften, 49: 499-500(Nov. 1962). (In German)

A study was made to determine if the well-known movements of mimosas and other sensitive plants can be affected or released by radiation. Plants were exposed to varying doses of radiation, and the results showed that at a sufficiently high dose the leaves responded within the first minute after exposure. The interval between exposure and response is a function of the dose received. Shielding reduces the effect. The response to radiation was called radionasty, in analogy to the concept of geonasty or nyctinasty. (J.S.R.)

12167 ROLE OF THE PITUITARY GLAND IN MELANIZATION IN THE SKIN OF THE GOLDFISH, CARASSIUS AURATUS, INDUCED BY X-RAY IRRADIATION. Nobuo Egami (National Inst. of Radiological Sciences, Chiba, Japan), Hisami Etoh, Chikashi Tachi, Kazuko Aoki, and Ryoichi Arai. Proc. Japan Acad., 38: 345-7(1962). (In English)

The role of the pituitary gland in the melanogenesis caused by x irradiation in the goldfish, Carassius auratus, was studied. It was concluded that the secretion of adrenocorticotropic hormone from the pituitary is stimulated by exposing goldfish to x radiation and that melanophores in the skin are produced by the overexcretion of the hormone. (C.H.)

12168 ACTION SPECTRUM FOR PALING (DECREASE IN REFRACTIVE INDEX) OF ULTRAVIOLET-IRRADIATED CHROMOSOME SEGMENTS. Raymond E. Zirkle and Robert B. Uretz (Univ. of Chicago). Proc. Natl. Acad. Sci. U. S., 49: 45-52(Jan. 1963).

An action spectrum was worked out for the process of chromosome paling, which is a result of ultraviolet partial-cell irradiation. In producing paling (probably due to a loss of nonaqueous material) in ultraviolet-irradiated segments of living chromosomes, the quantum effectiveness at wavelengths 2250, 2400, 2500, 2600, 2700, 2800, and 3000 A was found to have the relative values 220, 30, 10, 16, 19, 16, and 2.2, respectively. It was concluded that paling is most likely due to loss of both protein and DNA, possibly as some combination of the two, which is detached from the chromosome by photons absorbed by protein. (P.C.H.)

12169 THE ROLE OF THE LOCAL AND DISTANT EFFECTS OF TOTAL BODY X-IRRADIATION IN INJURING MICE OVARIES. O. N. Petrova. Tr. Inst. Genet., Akad. Nauk SSSR, No. 26, 180-8(1962).

Sexually mature line A, female mice, weighing 19 to 26 g

each were divided into 4 groups. One group was subjected to whole-body irradiation with a dose of 100 r, which was not lethal but caused irreversible sterilization. The 2nd group was subjected to local irradiation of the ovaries (irradiated area—30 × 18 mm). In the 3rd group only the heads were irradiated, while the 4th group was not irradiated at all. The estrual cycle of the animals was investigated by daily examining vaginal smears for the first 3 months and during the 6th and 9th months after irradiation. In addition, 3 and 6 months after irradiation all the mice were checked for fertility by placing them in the same cage with non-irradiated males for 2 weeks and recording the size of each liter and the number of stillborn progeny. The results showed that the injury caused by whole-body x irradiation of mice with a non-lethal sterilizing dose (100 r) is due to local damage of the ovaries. (P.C.H.)

12170 BACTERIOPHAGE INDUCTION IN E. COLI CELLS UNDER X-RAY ACTION. R. A. Ter-Pogosyan. Zh. Mikrobiol., Epidemiol. i Immunobiol., No. 7, 122-5 (1962).

A study was conducted to obtain bacteriophages from microbic cells during x irradiation and to find certain conditions favoring induction. A total of 317 coli cultures, isolated from children and rabbits, were tested. The cultures were sown in a test tube with 5 ml of Hottinger's broth with pH = 7.1 to 7.2 and incubated at 37°C. It was found that x radiation caused phage induction in 14 of the coli cultures, whereas the control tests with non-irradiated cultures were negative. The phage output depended on the dose and hardness of the x rays. The greatest phage output was observed during irradiation with relatively soft rays and low doses. Radioinduced bacteriophages were more frequently observed during the logarithmic growth phase than during the stationary phase of the cultures. Phages of several cultures induced during irradiation lost their melitose and xylose fermentation ability and their mobility. (P.C.H.)

12171 EFFECTS OF GAMMA RADIATION ON TWO VARIETIES OF SORGHUM VULGARE PERS. Haskell Byard Harris. Thesis, Athens, Ga., Univ. of Georgia, 1962. 115p.

An investigation was made on the effects of various gamma-radiation dosages (0, 10, 20, 30, 40, and 50 kr) on dormant seeds of two varieties of Sorghum vulgare Pers. as expressed in growth and reproduction of the X_1 and succeeding generations. Stimulative effects of low gamma-ray dosage were observed in the Shallu variety for seedling emergence and survival in the X_1 generation. A larger number of heads per plant and an increased weight of 100 seeds were observed in radiated populations; however, these were attributed to an indirect effect resulting as a consequence of increased sterility. Estimated critical dosage occurred between 20 and 30 kr for Redbine 60 and between 40 and 50 kr for Shallu. This estimate was based on 50% sterility in the X_1 generation. The dosage at which seedling height was significantly reduced in the X_1 generation was closely associated with 50% sterility. Redbine 60 was more susceptible to gamma radiation than Shallu. Variety x dosage interaction was evident in seedling emergence and survival (X_1), seedling height (X_1), mature plant height (X_1), percentage of dead leaf tissue at maturity (X_1), main stem head length (X_1), yield of grain per head (X_1 and X_2), yield of grain per inch of head (X_1 and X_2), and weight of 100 seeds (X_1 and X_2). The only dominant mutation observed in the X_1 generation was tall mutant. It occurred in the control and in all dosage populations. Significantly accelerated mutation frequencies (expressed as reduced seedling survival and increased sterility in the X_2 generation) were observed in the high dosage populations of both varieties. Actual counts of seedling lethals and other mutant types were greater in the high dosage populations. Mutations observed in the X_2 generation were arbitrarily grouped into five categories. Overlapping of categories occurred in many aspects. Most of the mutations appeared to be of a harmful nature. (P.C.H.)

Radiation Sickness

12172 (AD-278124) SYNTHESIS OF ANTIRADIATION DRUGS. Annual Progress Report, April 1, 1961–March 31, 1962. Robert J. Wineman and Morton H. Gollis (Monsanto Research Corp. Boston Labs., Everett, Mass.). July 20, 1962. Contract DA-49-193-MD-2109. 34p.

Forty-eight compounds were synthesized and evaluated as potential antiradiation drugs. These compounds were mainly N-substituted derivatives of 2-aminoethanethiol and were supplied as the hydrochloride salts. The synthetic methods used were: thiolethylation of amines and alkanolamines with ethylene sulfide; amination of epoxides and alpha, omega-alkylene dihalides with 2-(Benzylthio)ethylamine, followed by debenzylation; and alkylation of alkanolamines with benzyl 2-chloroethyl sulfide, followed by debenzylation. A study of the reaction variables in the ethylene sulfide thiolethylation of a simple aliphatic amine (n-hexylamine) was begun. The data indicate that high amine: episulfide molar ratios and long reflux periods favor formation of the monothiolethylated product in good yield. (auth)

12173 LEUKEMIA IN NAGASAKI ATOMIC BOMB SURVIVORS FROM 1945 THROUGH 1959. Masanobu Tomonaga (Hiroshima Univ.). Bull. World Health Organ., 26: 619-31(1962).

The Nagasaki leukemia experience during a period of 14 years is discussed together with comparisons with data from Hiroshima and other series of postradiation leukemia cases. The data demonstrate beyond reasonable doubt the leukemogenic effect of ionizing radiation on man. An increased risk of leukemia following doses probably as low as 100 rad (air-entry dose) of whole-body radiation is apparent on the basis of the available estimates of atomic bomb radiation doses. At doses above this level the increase in leukemia incidence may be linearly related to the radiation dose. The data suggest that young people may be more sensitive to radioinduced leukemia than older age groups. In Nagasaki and Hiroshima survivors exposed in utero, no case of leukemia has been identified to date. The first increase in leukemia incidence among the Japanese survivors occurred 18 months to 2 years following exposure, and the risk of leukemia has continued in the population as late as 14 years after exposure. In Nagasaki survivors, both acute leukemia of all types and chronic granulocytic leukemia have increased; 67% of 21 cases of chronic granulocytic leukemia occurred in people located at less than 2000 m whereas only 41% of all acute leukemias occurred in the group. In Hiroshima, the figures are 89% and 79%, respectively. That the incidence of chronic granulocytic leukemia is greater in Hiroshima than in Nagasaki may have implications, inasmuch as the Hiroshima survivors received 2 to 10 times greater neutron-induced doses, depending on different estimates. (P.C.H.)

12174 PREVENTION OF DELAYED FOREIGN MARROW REACTION IN LETHALLY IRRADIATED MICE BY EARLY ADMINISTRATION OF METHOTREXATE. H. L. Lochte, Jr., A. S. Levy, D. M. Guenther, E. D. Thomas,

and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Nature, 196: 1110-11(Dec. 15, 1962).

Mortal wasting occurs in lethally irradiated mice injected with allogenic marrow capable of reaction against host tissue antigens. Administration of methotrexate on the day after marrow injection and for a short period thereafter is noted to reduce or banish mortality. Restraint of the reaction of immunologically competent cells in the marrow infusion for a short time seems to account for the reduction. (D.C.W.)

12175 MAXIMUM PROTECTION OF MICE AGAINST 8-Mev ELECTRON IRRADIATION. Jennifer Shewell (St. Mary's Hospital Medical School, London), E. A. Wright, D. K. Bewley, and J. A. Silvester. Nature, 197: 91(Jan. 5, 1963).

Intraperitoneal crysteamine given before, hypoxia induced during, and intravenous injection of bone marrow cells after irradiation of mice with 8-Mev electrons produce an $LD_{50/30}$ of 2890-rads for x rays. This remarkable degree of protection falls far short of the product of each factor multiplied together (6-8 fold). (D.C.W.)

12176 THE CHANGE IN THE HIGHER NERVOUS ACTIVITY OF MONKEYS DURING RADIATION SICKNESS. Sh. L. Dzhalagoniya. Zh. Vysshei Nervnoi Deyatel'nosti, im. I. P. Pavlova, 12: 472-80(1962).

Steady conditioned reflexes were developed in monkeys and their higher nervous activity was studied before irradiation. The experiments were performed on 6 hamadryad female monkeys aged 7 to 10 yr. The animals were subjected to single whole-body x-irradiation of 378 r and 399 r, which resulted in phasic disorders in CNS activity, whose severity depended primarily on the typological characteristics of each animal. Thus, the same dose had a different effect on the brain, blood, and cardiovascular system of each animal. During acute radiation sickness, a prolonged suppression of cortical excitability occurred and there were signs of disorders in the main nervous processes. Conditioned reflex activity returned completely one and a half years after irradiation whereas the autonomous activity returned earlier. (P.C.H.)

12177 THE CHANGE IN VASOMOTOR AND SECRETORY CONDITIONED AND UNCONDITIONED REFLEXES DURING ACUTE RADIATION SICKNESS. D. A. Il'inskii. Zh. Vysshei Nervnoi Deyatel'nosti, im. I. P. Pavlova, 12: 521-9(1962).

Regulation of the vascular tonus as a function of the general condition of CNS during acute radiation sickness was studied. The reflex reactions were studied by recording the plethysmographical changes in the vascular lumen of the marginal vein of the ear and by measuring the saliva secretion from the parotid gland in dogs. An unconditioned stimulus in the form of a 0.25% HCl solution sprayed into the mouth cavity, produced vascular constriction and saliva secretion. Four female dogs were subjected to simultaneous bilateral irradiation. The dose was 500 r at 6.3 r/min. The conditioned and unconditioned vascular and secretory reflexes were altered phasically and in a similar manner with the progress of radiation sickness. CNS was affected on both cortical and subcortical levels, especially in severe cases. At the terminal stage of the sickness a diffuse suppression of CNS activity was observed. The pathogenesis of the general vascular disorders in radiation sickness originated to a great extent from the functional disorders of the higher levels of CNS. (P.C.H.)

12178 CANCER AND BACKGROUND RADIATION. A. Segall. Thesis, Boston, Harvard University, 1961.

The possible relation between terrestrial background radiation and leukemogenesis was investigated in northern New England townships. Natural radiation was not found to be measurably leukemogenic at the dose rates operative in the communities investigated. (P.C.H.)

CHEMISTRY

General and Miscellaneous

Refer also to abstract 12590.

12179 (ANL-6642) THE NITRIDATION RATES OF URANIUM–FISSIUM ALLOYS. J. P. LaPlante and R. K. Steunenberg (Argonne National Lab., Ill.). Nov. 1962. Contract W-31-109-eng-38. 28p.

The nitridation rates of U–5% fissium alloys were investigated at about 200 to 650°C and at N_2 concentrations in Ar from about 0.5 to 100%. The effects of Na coatings and irradiation of the alloy were examined. The nitridation rates of the alloys followed a parabolic law, with activation energies between 14 and 16 kcal/mole. The ignition behavior of irradiated alloy in N_2-Ar mixtures was investigated briefly. (auth)

12180 (BNL-6033) THERMODYNAMICS OF SOLUTIONS OF ACTINIDES AND FISSION PRODUCTS IN BISMUTH. Richard W. Wiswall, Jr. and James J. Egan (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 43p.

A review is given of the thermochemistry of the liquid systems of Bi with Th, Pa, U, Pu, and the high-yield fission products. Data were obtained chiefly from measurements on galvanic cells, of which U(s)|LiCl–KCl(eut.) + 5% UCl_3(l)|U–Bi(l) is illustrative. The free energies of mixing were obtained for dilute solutions of Ce, U, Th, and Zr in Bi. Less precise but still significant information on the properties of Sm, La, Nd, Tc, Te, Ru, Rh, Pd, Pa, Cs, and Ba in bismuth was obtained from experiments on their distribution between liquid metal and fused salt phase or between two liquid metals. (auth)

12181 (LAMS-2832) THE SOLUBILITY OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. I. CARBON. D. F. Bowersox and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). Dec. 18, 1962. Contract W-7405-eng-36. 11p.

The solubility of C in liquid Pu was measured at 700 to 950°C. The solubility increases from 690 ppm (by weight) C at 700 to 2350 ppm C at 950°C. The data fit the empirical equation $\log N_C = 0.50 - 2.30 \times 10^3\, T^{-1}$, where N_C is the mole fraction of C and T is the temperature in degrees Kelvin. (auth)

12182 (NBL-188) ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1961–JUNE 1962. (New Brunswick Lab., AEC, N. J.). Dec. 1962. 101p.

The procedure of Menis and Manning for the determination of silicon in thorium dioxide was modified so that very refractory samples can be analyzed. A method for the determination of total uranium in metal-clad uranium fuel elements by measuring the attenuation of the 0.34 Mev gamma ray of europium-152, 154 was demonstrated. The method uses a gamma-ray spectrometer to discriminate against the uranium-235 gamma rays and uses an equation to correct the absorption of the cladding metal absorption. The precision and accuracy are of the order of one per cent. A limitation was noted and measured in the method used to determine the total uranium-235 in flat fuel elements, when the absorption correction for cladding metals, such as zirconium and stainless steel, becomes appreciable. Extensive data are presented. The absolute disintegration rate of an americium-241 alpha source, for use in calibration of alpha counting equipment, was determined by means of the alpha-gamma coincidence method with a precision of 0.6% and a probable accuracy of 1 to 2%. A cation-exchange separation of silicon from plutonium is made prior to spectrographic determination. In the spectrographic analysis of boron in plutonium, about half of the boron is lost when 8N nitric acid solutions are evaporated to dryness on graphite electrodes. An investigation of the use of mannitol to complex boron and prevent volatilization during evaporation was extended to higher nitric acid concentrations not previously reported. Quantitative retention of boron in 8N nitric acid was obtained only at 6000 to 1 mannitol to boron mole ratios. At all other lower mannitol concentrations, excessive degradation by the nitric acid resulted in boron recoveries of less than 90%. Plutonium sulfate tetrahydrate, $Pu(SO_4)_2 \cdot 4H_2O$, 99.99% pure, studied as an analytical standard for several years, has been prepared from high-purity metal (99.97%). A material of at least 99.995% purity was prepared by recrystallization, or by ion-exchange purification of this compound. Preparation of the tetrahydrate from impure waste solutions (<90% purity) provides material of 98.2, 99.72, and 99.92% purity with three successive recrystallizations. The use of anhydrous plutonium sulfate, $Pu(SO_4)_2$, as a gravimetric weighing form for plutonium was studied. When plutonium sulfate tetrahydrate is ignited at 325°C for 48 hours, a stoichiometric compound results, but present tests show that heating slurries or solutions of the tetrahydrate in concentrated or 1 to 2N sulfuric acid does not produce the anhydrous sulfate even after 100 hours at the above temperature. Igniting the tetrahydrate dissolved in 0.1N sulfuric acid for periods up to 81 days produced a variegated material of constant but nonstoichiometric weight. Plutonium is separated from uranium in plutonium-uranium oxide and plutonium-uranium carbide reactor fuel elements by cation exchange. Initially the refractory oxide or carbide is dissolved by refluxing in concentrated nitric acid–6N hydrofluoric acid solution. After separation, plutonium is determined by potentiometric titration with potassium dichromate; uranium may be determined similarly. At least 99.9% recovery of both plutonium and uranium was obtained. The evaluation of dicesium plutonium hexachloride as a primary plutonium standard was continued. Current investigations of the stability of Cs_2PuCl_6 indicate continuing instability as the material consistently loses weight and evolves acid vapors while in storage. Hydrolysis of the compound is suspected as the cause of instability. The uncertainty in the experimental value obtained for the efficiency factor of an alpha proportional counter was determined by calibration with prepared plutonium standards using ordinary techniques. A value of 49.91 ± 0.57% (95% confidence level) indicated the need for more refined calibration methods for highest accuracy in plutonium assay. The study of the spectrographic determination of trace impurities in high-purity plutonium following the anion-exchange separation from plutonium in 8N nitric acid was continued. Additional procedures were developed for the estimation of potassium, cesium, rubidium, and for the analysis of plutonium sulfates using a hydriodic acid treatment for sulfuric acid removal from the ion-exchange effluent. The use of "boiler cap" electrodes and various photographic emulsions to increase the sensitivity of the method was investigated. The loss in sensitivity caused by modification of the spectrograph for gloved box operation is 50%. Twenty-two elements (Fe, Mn, Mg, Pb, Cr, Ni, Al, Ag, Zn, Mo, Cu, Be, B, Cd, K, Na, Cs, Rb, Ba, Li, Pu, and Am)

can be determined by the method. The sensitivity of the method for plutonium was determined. A chemical uranium bias check program carried out in the reactor field is presented. It includes data pertaining to the preparation of synthetic known solutions similar in composition to the fuel element in question, as well as the analytical steps employed for the purpose of verifying the uranium content. A volumetric procedure for determining boron in plastic tape impregnated with boron carbide is described. The ash residue from a sodium carbonate-treated specimen is decomposed by fusion and interfering elements removed by filtration after adjusting the test solution to pH 5.0 to 5.5. Boric acid is titrated with standard 0.1N sodium hydroxide in the presence of mannitol. A ratio method of uranium isotopic analysis previously described was evaluated for accuracy by analyzing National Bureau of Standards (NBS) certified standards and new Brunswick Laboratory gravimetrically prepared materials. A systematic procedure is presented to permit the reporting of an isotopic measurement with an accuracy within that certified by NBS of the same level. Also, it is shown that gravimetrically prepared materials may be useful in determining the accuracy of small concentrations of U^{234} and U^{236}. A rapid method is described for determining various impurities in beryllium metal by x-ray fluorescence using the characteristic radiation of the tungsten peak as a built-in internal standard. X-ray analysis is described as a rapid technique for the analysis of uranium in UO_3-stainless steel materials within 5% of the uranium content. (D.L.C.)

12183 (ORNL-3375) TRANSURANIUM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING AUGUST 31, 1962. D. E. Ferguson, comp. (Oak Ridge National Lab., Tenn.). Feb. 1, 1963. Contract W-7405-eng-26. 59p.

The development of separation processes for the transuranium elements, process-equipment development, HFIR target-fabrication development, design of the TRU facility, design of development facilities, corrosion studies, analytical research and development, and the preparation of U^{232} samples for research are reported. Process Development. Chemical processes and related equipment for the Transuranium Element Program are being developed. Progress is reported on the Tramex process, which is an amine solvent extraction from concentrated lithium chloride solutions to separate the transplutonium elements from corrosion and fission products. Another solvent extraction process for recovering americium and curium in nitrate wastes from plutonium processing is also reported. The Tramex process was tested in laboratory scale runs with irradiated Am^{241} added at low activity levels, and recoveries of greater than 99.8% were obtained. The decontamination factor from mixed fission products was about 5000. The decontamination factor for ruthenium, which was the limiting contaminant, was about 1000. Preliminary tests with sodium nitrite added to the stripping solution to oxidize ruthenium to the tetravalent state, thus keeping it in the solvent, gave ruthenium decontamination factors of about 10^4. Small-scale (1-2 ml) batch tests of the Tramex process at 10 w/liter, which is the proposed processing level, gave the same distribution coefficients noted in tracer-level experiments. Faster separation of the mixed phases noted at this radiation level is beneficial. Equipment was fabricated for additional testing at full activity level. Distribution coefficients determined for Tramex conditions show that Pu^{4+}, Sb^{3+}, Sn^{2+}, and Ba^{2+} are separated from the transplutonium elements. The first three ions are extracted but remain in the solvent as the transplutonium elements are stripped into 4 to 10M HCl. Although Ba^{2+} follows the transplutonium elements during stripping, it can be prevented from entering the solvent in the first place if the $AlCl_3$ concentration in Tramex feed is less than a few hundredths molar. The solvent extraction process being considered for Am-Cm recovery from plutonium process waste is an alternative to the anion exchange method discussed previously. Like the anion exchange process, it is primarily useful in separating americium and curium from aluminum and also removes some fission products but not the rare earths. The extraction method was laboratory tested with simulated feed containing Cm^{242} tracer. The results were good with curium recovery of 99.8%. Though americium tracer was not used, it is probable that its recovery would have been at least as good as the curium recovery. Equipment Development. Equipment development was continued on the evaluation and improvement of the contacting equipment used in the transuranium elements processing program. The Tramex flowsheet was used with nickel as a stand-in for americium and curium. Nickel was used because its extraction coefficient permits column operation at the same flow ratio as specified by the transuranic flowsheet. Small-scale (0.82- and 0.75-in.-ID) pulsed columns were used as the contacting equipment. The results show that the extraction rate for nickel is adequate for conventional solvent extraction contactors. The stage-heights obtained with a pulse column, although three to four times higher than those for uranium extraction by TBP, are encouraging, considering the high viscosity of both the solvent and the aqueous phases. Sieve plates were superior to glass helical packing, based on efficiency and throughput. HFIR Target Fabrication Process Development. Work was continued on the development of target-fabrication procedures, the development of equipment for target fabrication in the TRU Processing Facility, the development of plutonium-target-fabrication equipment, and the planning of procedures and methods to be used in the fabrication of HFIR target-irradiation prototypes. Welding studies led to the establishment of a technique that appears suitable for producing leak-tight end closures, with about 70% penetration. Pellet-fabrication studies set 50 mils as the minimum thickness of the aluminum-powder cap, and expansion measurements indicated that the expansion characteristics of reference pellets are comparable with those of type 1100 aluminum. The thermal conductivity of simulated target pellets was found to be a sensitive function of the actinide oxide loading, decreasing rapidly with increasing oxide content. Neutron activation tests showed that the reference pellets were permeable to fission gases. The pellet-fabrication press was completed and successfully operated in preliminary tests. Several items of similar equipment for the plutonium target-fabrication line are being built or procured. Design Studies. Work was continued on the design of the process test facility, shielding studies, the design of chemical processing equipment, scheduling, and the TRU Facility. The design of the process test equipment is about 85% complete. The installation of the storage tanks for feed solutions in cell 4 pit is complete, and the shielding is complete. The cell walls proper were coated with epoxy glass-fiber lining in preparation for the installation of piping and other process equipment. Shielding studies were made in order to determine a suitable aggregate for use in the TRU shielding concrete. The shielding criteria are that it should attenuate the neutrons and gamma rays from a 3×10^{12} neutron/sec fission source such that the dose rate at the outside surface of the 54-in.-thick wall is less than 1 mrem/hr when the source is located 2 ft from the inside surface. Montana magnetite was preferred on the com-

bined basis of shielding requirements and cost. Work on the design of chemical-processing equipment was directed towards completing preliminary equipment and engineering flowsheets. In conjunction with this, materials of construction for all equipment items and piping systems were tentatively assigned. The feed-adjustment tanks including the vessel head and all dip tubes must be of tantalum or be tantalum lined. Product storage tanks will probably be made of tantalum-lined Hastelloy C, with Zircaloy tops and dip tubes. Materials Evaluation Studies. Radiation resistance and ease of decontamination of protective coatings for use in certain parts of the TRU Facility were studied. TRU Corrosion Studies. The study of corrosion in process solutions of proposed materials of construction for the TRU Processing Facility was continued. The corrosion resistance of welded specimens of Hastelloy B was superior to that of Hastelloy C in Tramex process solutions which contained either oxygen or hydrogen peroxide. The presence of ferric ion accelerated the corrosion of both Hastelloys from 5 to 10 mils/month to about 20 mils/month at 43°C. Niobium was found to be subjected to hydrogen embrittlement in the various chloride-containing solutions. Both tantalum and Zircaloy-2 exhibited acceptable corrosion rates and resistance to hydrogen embrittlement under simulated process conditions. Analytical Development. During this reporting period, alpha spectrometry was applied to the determination of Am^{241} in the presence of Cm^{242}. A 256-channel nuclear-data analyzer in conjunction with a silicon diode detector was used in conjunction with the work. After appropriate chemical treatment of the process solutions (Cm^{242} containing Am^{241} in the range 0.3 to 1.4%), the solutions were analyzed, and the uncertainty was ±10%. Equipment is being readied for the absorption-spectrophotometric studies on the transplutonium elements. Uranium-232 Preparation. Five samples of U^{232} were recovered and purified from two successive irradiations of 50 g of Pa^{231}. The recovery and purification methods are reported. (auth)

12184 (TID-17903(and Add. 1)) SPECIFICATIONS FOR A HOT CAVE RADIOCHEMISTRY LABORATORY PROJECT. V. Herrero Climent (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies). Sept. 1962. Includes Addendum 1, dated Jan. 1963. Contract [AT(11-1)-1167]. 49p.

Designs for a new radiochemistry laboratory provided with a hot cave are presented. The laboratory is to be built from the existing adjacent laboratories labeled F-14 and F-15 at the Enrico Fermi Institute. The hot cave is modeled after the ANL "Junior" type cave. Details of construction plans are given. (J.R.D.)

12185 (SCL-T-462) SYNTHESES OF HIGH POLYMERIC SEMICONDUCTORS. Masahiro Hatano. Translated by Noburu Hiraga (Sandia Corp., Albuquerque, N. Mex.) from Yuki Gosei Kagaku Kyokai Shi, 20: 326-42 (1962). 40p.

Data and information concerning the synthesis and characteristics of high polymeric semiconductors are presented. The synthesis of conjugated π electron systems is examined along with the synthesis of highly polymerized chelate compounds and the synthesis of charge-transfer-type high polymeric semiconductors. (J.R.D.)

12186 CATALYTIC ACTIVITY OF COPPER–NICKEL ALLOYS AS A FUNCTION OF ARGON-ION BOMBARDMENT CURRENT AND ANNEALING. Toshiro Yamashina and H. E. Farnsworth (Brown Univ., Providence). Ind. Eng. Chem., Prod. Res. and Develop., 2: 34-7(Mar. 1963).

Using ultra-high-vacuum techniques and a mass spectrometer for continuous gas analysis, the hydrogenation of ethylene at partial pressures of 1.5 torr was observed for five Cu–Ni alloy catalysts. The activity of each sample passed through a maximum for ion current densities between 120 and 200 μa; the optimum current density increased with increase in amount of copper in the alloy. A maximum activity of 15 times that of pure nickel was observed for the 60.5% Cu alloy. Short anneals after ion bombardment produced an abrupt decrease in activity at a critical temperature, which increased with decrease in copper content. (auth)

12187 VELOCITY DEPENDENCE OF ION-MOLECULE REACTION CROSS SECTIONS IN A MASS SPECTROMETER. Don A. Kubose and William H. Hamill (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc., 85: 125-7(Jan. 20, 1963).

The cross sections Q of ion-molecule reactions were studied in a mass spectrometer as a function of primary ion energy E_0. Reactions were of the type $X^+ + RH \rightarrow XH^+ + R$, where R is a non-polar molecule. The results showed that Q is not proportional to $E_0^{-\frac{1}{2}}$ over the range. At large E_0, Q was linear in E_0^{-1} beyond a well defined transitional energy. The results cannot, in either energy interval, be described in terms of point particles. Allowing for head-on collision cross sections, taken to be energy independent, led to expressions of the type $Q = aE_0^{-\frac{1}{2}} + b$ for small E_0 and $Q = cE_0^{-1} + d$ for large E_0. The results are well described by these equations. (auth)

12188 SOME CO-ORDINATION POLYMERS PREPARED FROM BIS-(β-DIKETONES). J. S. Oh and John C. Bailar, Jr. (Univ. of Illinois, Urbana). J. Inorg. Nucl. Chem., 24: 1225-34(Dec. 1962).

A series of metal ion-bis-(β-diketone) polymers containing beryllium, copper(II), nickel(II), zinc(II), or cobalt(II) were prepared by four different methods. Three types of structures are postulated on the basis of elementary analysis of the polymers. The thermal stability of the polymers was studied by a relatively simple method, utilizing a thermogravimetric balance. It was found that, in general, the order of thermal stabilities is Be(II) > Cu(II) > Ni(II) > Zn(II) > Co(II). The polymers derived from bis-(benzoylacetones) and bis-dibenzoylmethanes) are thermally more stable than those derived from the corresponding bis-(acetylacetones). Similarly, the polymers derived from bis-(β-diketones) containing no connecting link between the diketone groups are thermally more stable than the polymers derived from the corresponding bis-(β-diketones) which contain a connecting link. The stabilities depend upon this connecting link in the following order: $-(CH_2)_2-N \sim -CH_2- \bigcirc -CH_2- > -CH_2- > -C(\phi)H-$. The beryllium polymers do not all conform to these generalizations. (auth)

12189 THE EXTRACTION OF HYDROCHLORIC ACID AND SOME METAL CHLORIDES BY TRI-n-BUTOXYETHYL PHOSPHATE. M. Halpern, T. Kim, and N. C. Li (Duquesne Univ., Pittsburgh). J. Inorg. Nucl. Chem., 24: 1251-6(Dec. 1962).

The physical chemistry of the extraction of HCl from aqueous solution by tributoxyethyl phosphate (TBEP) was studied. In addition to the conventional distribution and water content determination, physical–chemical measurements of electrical conductivity, density, and viscosity of the organic layer were carried out. The results indicate the formation of a monosolvate, HCl · TBEP. The extraction of chlorides of Zn^{2+}, In^{3+}, and Cr^{3+} from aqueous hydrochloric acid into undiluted TBEP and into mixtures of TBEP and benzene was studied using radioactive tracers. The extraction behavior of TBEP was compared with that of tri-n-butyl phosphate. (auth)

12190 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Henry Chapman Cowen and Robert Lind (to United Kingdom Atomic Energy Authority). British Patent 917,820. Feb. 6, 1963. Filed Aug. 24, 1960.

A method is outlined for inhibiting the $CO_2 + C \rightarrow 2CO$ reaction in graphite-moderated, CO_2-cooled reactors. The method comprises adding to the coolant 0.5 to 20 vol. % of H_2, CCl_4, $CFCl_3$, or CH_3OH, and monitoring the additive concentration in the coolant in the reactor. Reaction rate results are presented for tests of the effects of the above additives on the CO_2 + graphite reaction under electric arc conditions. (D.L.C.)

12191 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF MEMBRANE FILTERS. (to Membranfilter-Gesellschaft GmbH). British Patent 918,187. Feb. 13, 1963. Priority date Apr. 18, 1959, Germany.

A process is given for producing membrane filters with improved mechanical properties and chemical inertness. The process consists of dissolving polyvinyl chloride or chlorinated polyvinyl chloride in a mixture of liquids (one of which is a true solvent for the polymer and the other is a pore-forming liquid), pouring the solution into a layer on a flat surface, and evaporating the liquids from the layer. The true solvent preferably is ethyl acetate and the pore-forming liquid an alcohol having a short or medium chain length. The resulting membrane has a graded pore size of 0.1 to 6 microns, has a tensile strength about ten times higher than that of cellulose ester membranes of the same porosity, and is resistant to strong acids and alkalis. (D.L.C.)

Analytical Procedures

12192 (AAEC/TM-174) A MONITOR FOR THE CONTINUOUS DETERMINATION OF DEUTERIUM. R. R. T. Morgan (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Dec. 1962. 19p.

Details are given of a monitor for the continuous determination of deuterium in He. Excess O_2 is added to the gas stream and the O_2 concentration determined before and after passage of the gas through a deuterium-O_2 recombination unit. O_2 concentrations are measured with galvanic cells. The accuracy is better than ±10% at 200 to 5000 v.p.m. deuterium. Operating instructions for the equipment are given. (auth)

12193 (TEES-2671-2)) INVESTIGATIONS IN AUTOMATED ACTIVATION ANALYSIS. Lloyd E. Fite, Edgar L. Steele, Richard E. Wainerdi, et al. (Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station Activation Analysis Research Lab.). Nov. 1, 1962. Contract AT(40-1)-2671-1. 428p.

Progress made in a study concerning the basic technology of activation analysis and its applications is reported. The feasibility of the computer-coupled automatic approach to activation analysis was established. Two systems based on the automated concept were designed. It is noted that the art of nuclear activation analysis is at an early stage of development. Efforts in the program are devoted largely to procedure development. (J.R.D.)

12194 (TID-16090) A SEMI-AUTOMATIC APPARATUS AND METHOD FOR ALPHA ACTIVITY DETERMINATION IN URINE. T. C. Whitson and T. Kwasnoski (Oak Ridge Gaseous Diffusion Plant, Tenn.). [nd]. Contract [W-7405-eng-26]. 14p.

A method and a semi-automatic apparatus are described for the separation of alpha activity associated with uranium in urine. Uranium is adsorbed from partially digested urine on a micro bead column coated with tri-n-octylphosphine oxide. The adsorbent and uranium are eluted with alcohol onto a watch glass for drying, ignition and counting of alpha activity. The adsorption and elution operations are performed on a semi-automatic apparatus. Recovery of alpha activity from 0.016 μg of enriched uranium in 100 ml. of urine is 92% with a precision of ±33%. (auth)

12195 LOW-LEVEL CARBON-14 DETERMINATION BY IMPROVED SCHÖNIGER COMBUSTION AND IONIZATION CHAMBER. Susanne von Schuching and Carl W. Karickhoff (Veterans Administration Center, Martinsburg, W. Va.). Anal. Biochem., 5: 93-8(Feb. 1963).

A procedure for measuring low levels of C^{14} radioactivity, diluted with large amounts of inactive carbon in heterogeneous samples, was developed. The design of a Schöniger type combustion flask for the conversion of liquid and solid samples to barium carbonate and the ionization chamber for measuring the activity of carbon dioxide are given. The procedure is useful for all types of heterogenous samples encountered in biological experiments. (P.C.H.)

12196 ANALYSIS OF ESTROGENS WITH BROMINE-82. W. R. Slaunwhite, Jr., and Lavalle Neely (Roswell Park Memorial Inst., Buffalo). Anal. Biochem., 5: 133-42(Feb. 1963).

A new method for analyzing phenolic steroids is reported. It consists of dibromination with Br^{82}, a gamma emitter with a half life of 36 hr. The method is very sensitive (1 mμg), reasonably accurate (>80% recovery from urine, >95% recovery from plasma at the 10-mμg level), quite precise (±3%), and highly specific. Specificity is assured by gradient elution chromatography, followed by dilution with carrier and recrystallization to constant specific activity. (P.C.H.)

12197 DETERMINATION OF ALUMINUM, CERIUM(III) AND LEAD WITH FLUORIDE BY AN AMPEROMETRIC INDICATOR METHOD. Asha Varma (Hindu Univ., Banaras, India). Bull. Chem. Soc. Japan, 35: 1444-6(Sept. 1962).

Determinations of Al, Ce(III), and Pb by fluoride involving complex formation, $KAlF_6$ and precipitations, CeF_3 and PbClF or PbBrF were carried out successfully using the amperometric indicator method at 0.04 v with two identical polarized Pt electrodes. A small amount of ferric chloride is used as an indicator, the reduction of which beyond the end point constitutes the indicating system. Up to the equivalence point, the current remains constant, and then falls owing to the reduction of the trivalent iron complex which is formed on addition of excess fluoride. The method is simple in technique, sensitive, and rapid, and the results obtained are good and satisfactory with an accuracy of the right order of magnitude even at lower concentrations, as low as 10^{-4} M. At still higher dilutions the maximum error rises to about ±5.0%. (P.C.H.)

12198 THE PRECIPITATION REACTION OF VARIOUS METALLIC IONS WITH PHENYLARSONIC ACID AND ITS DERIVATIVES. Hisakazu Nakata, Yuzuru Kusaka, and Shigeaki Kikkawa (Konan Univ., Kobe, Japan). Bull. Chem. Soc. Japan, 35: 1611-14(Sept. 1962).

Precipitation reactions of twenty-one different metallic elements with benzenearsonic acid and its derivatives were studied. Benzenearsonic acid, p-hydroxy-, p-amino-, o-nitro-, m-nitro-, p-nitro-, and 4-hydroxy-3-nitrobenzenearsonic acids were used as reagents. The tabulated results show that it is possible to formulate some general rules on the precipitation of various elements by benzenearsonic

acid and its derivatives. In each arsonate, as compared with the benzenearsonates, the nitro- derivatives seemed to be precipitated in a more acidic medium. In the nitro derivatives, the order was generally from the para and the meta and to the ortho form. The p-hydroxy- and the p-amino-derivatives seemed to be precipitated in a more basic medium. (P.C.H.)

12199 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM(III) AND SOME RARE EARTHS WITH XYLENOL ORANGE. Kôichi Tonosaki and Makoto Otomo (Hirosaki Univ., Aomori, Japan). Bull. Chem. Soc. Japan, 35: 1683-6 (Oct. 1962).

A method is described for the spectrophotometric determination of 20 to 100 μg of a rare earth element using xylenol orange. The complexes of Ce(III), La(III), Nd(III), and Y(III) with xylenol orange have an absorption maximum at 575 to 578 mμ vs the reagent blank. Each of them is a 1:1 complex and has a formation constant of approximately 10^5 under the conditions studied. Anions such as NTA and EDTA inhibit the color development of the complexes. (P.C.H.)

12200 THE DETERMINATION OF THORIUM BY EMISSION SPECTROSCOPY IN THORIUM MINERALS. E. Cerrai and R. Trucco (CISE, Milan). Energia Nucl. (Milan), 10: 16-25(Jan. 1963). (In English)

Spectrographic dc arc determination of thorium in an India monazite was carried out with a direct method on the powdered ore mixed to graphite powder. A 1.788 (±0.012) wt % thorium content was found whereas the chemical analysis determination gave 1.910 (±0.020) wt %. The spectrographic determination on the solution obtained through the chemical treatment gave the following results: 1.918 (±0.041) wt % with the dc arc method and 1.902 (±0.027) wt % with the copper-spark method, both with the aid of zirconium as the internal standard. The working equations for these two methods were experimentally determined. They represent straight lines which hold from 20 to 100 ppm of thorium in the former case and from 4 to 40 μg/ml of thorium in the latter case. As expected, certain improvement of the copper-spark method can be reached by using a piloted spark source unit and a higher performance spectrograph. Accuracy and reproducibility are thus increased and a better sensitivity allows measurements in a concentration range from 2 to 40 μg/ml. (auth)

12201 THE DETERMINATION OF TRACE ELEMENTS BY NEUTRON ACTIVATION ANALYSIS. Hideo Shiraishi. Fuji Jihō, 35: 281-6(Feb. 1962). (In Japanese)

A method for the determination of trace elements in many types of materials is given. The samples are irradiated in a thermal neutron flux. Gamma spectrometry and β-counting with radiochemical separations are employed. The results indicate that the most important factor in the tests was the radiochemical purity of the chemically separated fractions. Nuclear reactions of the formation of radioisotopes, such as As^{77}, Nb^{95}, Nb^{97}, Tc^{97m}, Tc^{99}, and Rh^{105}, from other elements are tabulated. Generally, the method gives an error of 10%. (P.C.H.)

12202 DIFFERENT VALUES FOR CAESIUM IN G-1. J. R. Butler and A. J. Thompson (Imperial Coll., London). Geochim. Cosmochim. Acta, 26: 1349-50(Dec. 1962). (In English)

Cesium was determined in two different granite G-1 samples by activation techniques. Values of 2.3 and 1.6 ppm were obtained. The activation method was a modification of that developed by Cabell and Smales. It was concluded that cesium amounts vary from sample to sample and different values do not necessarily mean faulty analytical techniques. (M.C.G.)

12203 COMPUTATIONAL METHODS IN MOLECULAR SPECTROSCOPY. L. A. Gribov. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1226-30(Oct. 1962). (In Russian)

Analytical methods based on the measurement of molecular vibration have assumed great importance. Compound scattering and infrared absorption yield information concerning the vibration motion of the molecules; the spectra obtained represent a complex picture of the geometry of the molecular structure. In this connection, the determination of the electro-optical parameters of the molecule by means of intensity and polarization measurements represents an important problem. The intensities may be obtained by calculating the vector sums of dipole moments of each constituent group for a given vibration; this depends not only on the number of similar groups but also on their mutual location, amplitude and vibrational phases. (TTT)

12204 CHOICE OF THE OPTIMUM QUANTITY AND CONSTITUTION OF THE TRACER USED FOR ISOTOPIC DILUTION ANALYSIS. E. A. C. Crouch and R. K. Webster (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc., 118-31(Jan. 1963).

A detailed treatment of the dependence of the error in a mass-spectrometric determination on the constitution of the tracer or the quantity used was made. Relations are derived between the measured isotopic ratios and the required quantity, so that uncertainty in the latter can be related to experimental errors in the former; they allow the most suitable tracer and the optimum quantity to be chosen. Errors caused by mass discrimination are also considered. The principles involved are outlined, illustrated, and applied to the rubidium-strontium method of age determination. (auth)

12205 SEPARATION AND DETECTION OF HYDROGEN, TRITIUM HYDRIDE, AND TRITIUM AT LOW-LEVEL TRITIUM ACTIVITIES BY GAS CHROMATOGRAPHY. E. H. Carter, Jr., and Hilton A. Smith (Univ. of Tennessee, Knoxville). J. Phys. Chem., 67: 535-6(Feb. 1963).

The analysis of a 3-ml gaseous mixture of H_2, HT, and T_2 with a total T_2 mole fraction of 10^{-16} to 10^{-13} is reported. Separation was effected on two 8-ft 20% ferric oxide-on-alumina columns with He carrier at 77°K. Detection of H_2 was by thermal conductivity and of HT and T_2 by a G-M flow counter. (D.L.C.)

12206 GAMMA SPECTROMETRIC DETERMINATION OF CESIUM-137 IN FOOD MATERIALS. Noboru Yamagata and Kiyoshi Iwashima. Koshu Eiseiin Kenkyu Hokoku, 10: No. 3, 135-8(Sept. 1961).

Radioactive Cs^{137} and potassium were determined in total diet samples by multi-channel gamma spectroscopy, by the use of a heavily shielded 7.5 × 7.5 cm NaI (Tl) crystal as a detector. The sensitivity of the method is 50 – 100 μμC with an error of ±10 – 20%. The accuracy is 5% when Cs^{137} is present in amount of more than 200 μμC. (Public Health Eng. Abstr., 43: Nos 1-2, Jan.-Feb. 1963)

12207 POTENTIOMETRIC OXIDIMETRIC DETERMINATION OF RUTHENIUM WITH LEAD TETRAACETATE. Ivan Němec, Antonín Berka, and Jaroslav Zýka (Charles Univ., Prague). Microchem. J., 6: 525-37(Dec. 1962).

It was established that tetravalent rubidium is oxidized in a medium of perchloric acid at room temperature by lead tetraacetate to Ru(VIII) oxide. Under suitable conditions this reaction is immediate and quantitative, so that it may be employed for a precise potentiometric determination of ruthenium. By using a 0.1N lead tetraacetate solu-

tion, it is possible to determine 5 to 15 mg Ru in the acidity range 0.03 to 0.1N $HClO_4$ at room temperature by direct titration. A 0.05N solution of the reagent may be used to determine 2 to 10 mg Ru in a volume of 50 ml. (auth)

12208 MICROANALYTICAL TECHNIQUES IN THE ANALYSIS OF HIGHLY RADIOACTIVE MATERIALS. Myron T. Kelley (Oak Ridge National Lab., Tenn.). Microchem. J., Symp. Ser., 2: 939-57(1962).

In the analysis of highly radioactive materials, the use of a small sample is desirable to limit the shielding required and to reduce the possibilities of contamination. With such limited samples, microanalytical techniques are employed that can be adapted to remote control. Liquid samples of 5 to 700 μl are measured with a servo-actuated pipettor with a precision of 0.3%. Coulometry is ideally suited to remote applications, e.g., the determination of uranium, copper, and nickel in a single sample of an aqueous homogeneous reactor fuel. Plutonium and neptunium can likewise be readily and precisely determined. Polarography is useful for determining reducible ions. Uranium in sub-microgram amounts is determined by extraction followed by fluorimetry. Spectrophotometry is widely used despite difficulties in maintaining clean cuvettes by remote manipulation. Many constituents of radioactive samples are determined by radiochemical methods; inactive constituents must also be determined. Thus, alkali metals are determined by flame photometry and some impurities by emission spectroscopy. Sulfate is titrated to a spectrophotometric endpoint, and acids to a potentiometric or conductometric endpoint. Density is measured on 5-μl samples by a falling drop technique. (auth)

12209 RAPID DETERMINATION OF TUNGSTEN IN STEEL BY NEUTRON ACTIVATION AND γ-RAY SPECTROMETRY. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Nature, 196: 1088(Dec. 15, 1962).

A neutron activation analysis method for nondestructive, rapid determination of tungsten in steel involves irradiation of 0.01-0.1 g samples with a neutron flux of 3×10^{11} neutrons/cm^2/sec and subsequent observation of the γ spectra and the decay of the nuclide formed. Accuracy of the method and amounts of other elements needed to produce interference are discussed. (D.C.W.)

12210 DETERMINATION OF IMPURITIES BY NEUTRON ACTIVATION ANALYSIS. I. DETERMINATION OF COBALT IN NICKEL BY ACTIVATION ANALYSIS. Yuichiro Kamemoto and Shigeru Yamagishi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 4: 866-8(Dec. 1962). (In Japanese)

Neutron activation analysis is investigated by means of determining trace quantities of cobalt in nickel metal and nickel salts without chemical separation. The sample is irradiated simultaneously with a standard in a reactor at a neutron flux of about 10^{11} n/cm^2/sec for 2 hr or 3 days (5 hr each day) and then cooled for several days to decay out the induced activity of nickel. After cooling, the irradiated sample is mounted in a 3 × 3 inch sodium iodide crystal attached to a 256-channel pulse height analyzer. Cobalt is determined by gamma spectrometry, comparing the heights of photopeaks at 1.17 and 1.33 Mev of Co^{60} of the sample with those of standard cobalt. (auth)

12211 NEW MEDIUM FOR THE FALLING DROP METHOD OF ANALYSIS OF DILUTE HEAVY WATER. Te-chiu Chin and Tsing-lien Chang (Peking Univ.). Sci Sinica (Peking), 12: 147-8(Jan. 1963). (In English)

Use of n-butyl benzoate as a medium for the falling-drop method of analysis of heavy water is described. With known samples prepared from a standard of 15.859 ± 0.005 mol % D_2O, three calibration curves for various D_2O concentration ranges from 0 to 10.5 mol % at 33.50, 27.50, and 22.00°C were produced. The relative error of analysis was estimated to be about 0.1%. (M.C.G.)

12212 QUANTITATIVE DETERMINATION OF TERBIUM IN RARE EARTH YTTRIUM SUBGROUP MIXTURES. G. Ya. Gornyi (Inst. of Geological Survey, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 393-5(1962). (In Russian)

A quantitative determination of terbium in terbium preparations and terbium–yttrium mixtures was carried out by roasting terbium oxalates at 450 to 500°C for 5 to 6 hours, followed by determination of iodide isolated during the higher terbium oxide (Tb_4O_7) dissolution in acidified potassium iodide in CO_2 atmosphere. (R.V.J.)

12213 SEPARATION OF Cr, V, AND Ce FROM Mn BY ION EXCHANGE. R. N. Golovatyi and V. V. Oshchapovskii (L'vov State Univ., USSR). Ukr. Khim. Zh., 28: 518-21 (1962). (In Russian)

The dependence of thoron complexes of Mn, Cr, V, and Ce on solution pH was determined by ion exchange. Separation of Mn from Va, Cr, and Ce was achieved by a single chromatographic operation. A thoron method was developed for determining manganese in Al–Mn–Ce alloys. (R.V.J.)

12214 4-(α-PYRIDYLAZO)-RESORCINOL—A SENSITIVE REAGENT FOR THE PHOTOMETRIC DETERMINATION OF INDIUM. P. P. Kish and S. T. Orlovskii (Uzhgorod State Univ., USSR). Zh. Analit. Khim., 17: 1057-62 (Dec. 1962). (In Russian)

A sensitive reagent, 4-(α-pyridylazo)-resorcinol, is suggested for the photometric determination of indium. Optimum conditions of complexing at pH 6 to 8 were found, and the composition of the complex was established. The molar extinction coefficient of the complex at the maximum absorption (λ = 500 mμ) is 32800. Solutions of the indium complex follow Beer's law in the range 5 to 120 μg/25 ml of In. A photometric method was developed for In determination in solutions of pure salts and in industrial materials. The method permits the determination of microgram amounts of In in the presence of small amounts of Cd, Zn, Al, Mn, Cr, Cu, Sn, and Pb. (auth)

12215 PHOTOMETRIC DETERMINATION OF NIOBIUM BY MEANS OF XYLENOL ORANGE. A. K. Babko and M. I. Shtokalo (Inst. of General and Inorganic Chemistry, Kiev). Zh. Analit. Khim., 17: 1068-71(Dec. 1962). (In Russian)

A photometric method was worked out for determining Nb by means of xylenol orange in the presence of tartaric acid. The optimum conditions for the determination are: pH 2 to 3, and the Nb : tartaric acid ratio equal to 1 : 30. The composition of the niobium–xylenol orange complex is $Nb(XO)_2$. The molar extinction coefficient of the compound is 20000. (auth)

12216 SEPARATION OF SMALL AMOUNTS OF TANTALUM FROM NIOBIUM BY THE EXTRACTION OF TETRAPHENYLARSONIUM FLUOROTANTALATE. I. P. Alimarin and S. V. Makarova (Moscow State Univ.). Zh. Analit. Khim., 17: 1072-5(Dec. 1962). (In Russian)

It was established that Ta as fluorotantalate forms a compound with tetraphenylarsonium chloride, which can be extracted with chloroform. By means of a radioactive isotope, Ta^{182}, a study was made of the effect of the NaF concentration, and of the concentration of tetraphenylarsonium chloride, HCl, and H_2SO_4 on the percent extraction of Ta. It was found that Ta can be quantitatively separated from

Nb, Ti, and Zr by the extraction of tetraphenylarsonium fluorotantalate with chloroform. (auth)

12217 A TITRIMETRIC METHOD FOR THE DETERMINATION OF MOLYBDENUM IN ITS CARBIDES; NITRIDES, BORIDES AND SILICIDES. L. N. Kugai and T. N. Nazarchuk (Inst. of Metalloceramics and Special Alloys, Kiev). Zh. Analit. Khim., 17: 1082-5(Dec. 1962). (In Russian)

A method for the direct determination of Mo in refractory compounds is based on its titration at pH 4.6 with a citric acid solution in the presence of diphenylcarbazone and an inner light filter—a solution of brilliant green. (auth)

12218 DETERMINATION OF SMALL AMOUNTS OF HYDROGEN AND OXYGEN IN METALLIC URANIUM. I. A. Berezin and V. I. Malyshev. Zh. Analit. Khim., 17: 1101-4(Dec. 1962). (In Russian)

A method for the determination of hydrogen and oxygen in metallic U was developed. It is based on hot extraction of gases from the metal in vacuo followed by the spectrographic analysis of the gases evolved. The method permits the determination of hydrogen down to 1×10^{-4} wt. % in U samples of 0.1 to 1 g, and down to 1×10^{-2} wt. % of oxygen in U samples of 0.01 to 0.1 g. The relative experimental error is 12 to 20%. (auth)

12219 ON THE PREPARATION OF HAFNIUM 8-HYDROXYQUINOLINATE. O. M. Kalinkina and N. P. Rudenko (Moscow State Univ.). Zh. Analit. Khim., 17: 1120-1(Dec. 1962). (In Russian)

A method was developed for precipitating hafnium β-hydroxyquinolinate $Hf(C_9H_6NO)_4$. The composition of the compound was established. The thermolysis of hafnium 8-hydroxyquinolinate was also carried out. (P.C.H.)

12220 THE DESIGN OF AN X-RAY MICROPROBE ANALYZER FOR BIOLOGICAL SPECIMENS. Louis Zeitz. Thesis, Stanford, Calif., Stanford Univ., 1962. 113p.

The advantage of using the Cosslett-Nixon type point source of x rays as a source of exciting radiation in x-ray emission microanalysis is shown. Detailed calculations were carried out to estimate the theoretical lower limit of detectability of iron in a biological sample when the point source is used to its greatest advantage. The calculations suggest a detectability in the neighborhood of 0.003% for a 10 min integration time with samples of an average diameter of 15μ and a thickness of 100μ. The principals, which are evident from the calculations involved in the design considerations, are applied in the development of experimental apparatus for accomplishing x-ray micro-emission analysis. The results of the experimental determination of the limit of detectability of Fe in simulated biological samples are described. The experimental limit of detectability was found to be about one order of magnitude higher than the calculated value. Instrumental changes are suggested that could possibly bring the experimental value closer to the calculated. Finally, attempts at analyses for the Fe content of skin samples are described. Instrumental factors, which made it impossible to obtain the optimum detectability, first became evident in doing the analyses, and are discussed in some detail. The main problem limiting the application of the instrument to the detection of low percentage constituents, say of the order of 0.005%, is the inability to maintain the exciting radiation sufficiently constant, in space and time, so that the ratio system is capable of correcting for any fluctuations. (Dissertation Abstr., 23: No. 6, Dec. 1962).

12221 DIFFERENTIAL SPECTROPHOTOMETRIC DETERMINATION OF HAFNIUM IN THE PRESENCE OF ZIRCONIUM. Arnold Richard Johnson, Jr. Thesis, Corvallis, Ore., Oregon State Univ., 1962. 204p.

The application of differential spectrophotometry to the determination of Hf in the presence of Zr was investigated using mandelic acid, chloranilic acid, quercetin, and xylenol orange methods. A theoretical discussion of the application of Method II (transmittance-ratio) spectrophotometry to the determination of Hf in the presence of Zr is included. The relation, $\Delta C/C = \Delta A/SxC$, which is the basis for the determination of optimum concentrations, was derived. Only the xylenol orange was found to be really satisfactory for the determination of 0 to 5% HfO_2 in ZrO_2, which was the desired range. Although the other three systems were not found to be satisfactory for the desired range, it was found that they should be applicable to wider ranges of HfO_2 in ZrO_2. The use of mandelic acid made it possible to quantitatively precipitate Zr and Hf as the tetramandelates and by holding the total weight of the tetramandelates constant it was then possible to measure them differently in the ultraviolet region. A standard curve was constructed from 5 to 50% Hf tetramandelate in Zr tetramandelate. Chloranilic acid was found to be applicable to the determination of about 5 to 50% HfO_2 in ZrO_2. Differential measurements were made in the ultraviolet region in one molar perchloric acid solution. Quercetin seemed to offer a possibility for the determination of small amounts of Hf in the presence of Zr. Standard curves were run for solutions containing 0 to 10% HfO_2 and 0 to 5% HfO_2 in ZrO_2. The xylenol orange method was tested on three Zr-Hf ores. These were analyzed for both the total oxide content and for the % HfO_2 in the total oxide. The results were found to compare favorably with x-ray results. (P.C.H.)

12222 METHOD OF MEASURING THE AMOUNT OF MATERIAL FISSILE BY THERMAL NEUTRONS AND PRESENT IN ANY ARBITRARY SUBSTANCE, PARTICULARLY FOR CONTROLLING THE STATE OF EXHAUSTION OF FUEL ELEMENTS IN NUCLEAR REACTORS. (to Brown Boveri and Cie, Aktiengesellschaft). British Patent 917,776. Feb. 6, 1963. Priority date Sept. 2, 1960, Germany.

A method is outlined for measuring the amount of fissile material in irradiated reactor fuel elements and other substances. The method comprises irradiating the substance with thermal neutrons from an antimony-124-beryllium source, and measuring the fast neutrons produced by the fission. An apparatus for carrying out the method with fission chambers is described. (D.L.C.)

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Refer also to abstract 12609.

12223 (AD-275763) THE INTERACTION OF PARAMAGNETIC IONS WITH LATTICE VIBRATIONS. Technical Report No. AF-93. A. Kiel (Johns Hopkins Univ., Baltimore. Radiation Lab.). May 1962. Contract AF33(616)-6753. 168p. (N62-12533)

The theory of the interaction of a paramagnetic ion with the lattice vibrations in an ionic crystal is investigated. A generalization of the Van Vleck approach to spin-lattice relaxation is developed that allows the determination of the effective vibrating crystal field in a semi-empirical manner. The theory of relaxation effects in excited states of ionic crystals is presented in some detail. In addition to the conventional single phonon relaxation process, the theory of multi-phonon emission is developed as a tentative explana-

tion of the quenching of fluorescence observed in many paramagnetic crystals. The simple (one phonon) relaxation theory is applied to the case of the ^2E state of ruby. The theoretical predictions of the relaxation times are in good agreement with experimental observations. An investigation of the line width of the $^4T_2$ "green band" of ruby indicates that a simple relaxation process causes the broadening, and not strains, as is usually assumed. The line widths of a variety of states in rare earth crystals are also investigated on the basis of the simple relaxation theory. The theory of the multiphonon relaxation is applied to the $^4T_2 \rightarrow {}^2E$ decay in ruby with reasonable results. This same theory is also applied to the ^3P states of P_r^{3+} in $LaCl_3$ and is shown to predict the observed fluorescence. Another mechanism for the temperature dependence of the line breadth is developed that is based on the adiabatic variation of the local fields due to lattice vibrations. This adiabatic mechanism predicts the line width of the ^2E state of ruby over a wide temperature range. The adiabatic and relaxation line broadening mechanisms are compared for the rare earths. The former dominates at temperatures above the Debye temperature, while the latter dominates below this temperature. (auth)

12224 (AECL-1673) TABLES OF THE THERMODYNAMIC PROPERTIES OF HEAVY WATER. J. N. Elliott (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1963. 92p.

Vapor pressure, specific volume, enthalpy, entropy, and internal energy for D_2O are tabulated in British and in MKSA units from 390 to 700°F in 1° steps. The viscosity, specific heat, and conductivity are also tabulated in both systems of units. The equations used in the calculations are discussed. (auth)

12225 (HW-SA-2632) THE DISTRIBUTION OF BISMUTH(III) AND POLONIUM(IV) BETWEEN HYDROCHLORIC ACID AND TRILAURYLAMINE SOLUTIONS. John C. Sheppard and Richard Warnock (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 7, 1962. Contract [AT(45-1)-1350]. 14p.

A study was made of the distribution of bismuth(III) and polonium(IV) between HCl and HBr and xylene solutions of trilaurylamine at 25°C. Graphs of the distribution vs acid concentrations are given. Both bismuth(III) and polonium(IV) have second-power amine concentration dependences for both HCl and HBr, indicating that the species in the organic phase is $BiX_5(HAm)_2$ and $PoX_6(HAm)_2$, where HAm is the protonated trilaurylamine. Stripping experiments were carried out on the organic phase using various stripping agents. The general features of amine extraction of metal ions are discussed. (D.L.C.)

12226 (TID-15762) THE REACTION OF GRAPHITE WITH NITROGEN AND OTHER PERTINENT THERMODYNAMIC SYSTEMS STUDIED WITH A MASS SPECTROMETER. J. Berkowitz (Argonne National Lab., Ill.). Mar. 1962. Contract [W-31-109-eng-38]. 21p. (UAC-6215)

Experiments were conducted for analyzing equilibrium vapor compositions through the investigation of thermodynamic properties of a variety of materials. A Knudsen cell was constructed to hasten the approach of equilibrium in the graphite-nitrogen system. Results of the experiments concerning the reaction of graphite with nitrogen show the heat of formation of this species [$\Delta H_f(CN)$] to be 109 kcal/mole, implying that its dissociation energy, D(CN) = 7.5 ± 0.1 ev. These results substantiate previous experimental work in determining this thermodynamic quantity by optical spectra, electron impact, thermal measurements, and shock tube studies. (H.G.G.)

12227 (TID-16192) SOLUBILITY OF NEPTUNIUM(IV) PEROXIDE. E. K. Dukes and G. A. Burney (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Revised Dec. 4, 1961. Contract AT(07-2)-1. 8p.

The preparation of two crystalline forms of neptunium peroxide is described. An aliquot of pure neptunium(IV) stock was added to a mixture of HNO_3 and H_2O_2. The mixture was agitated and then the peroxide precipitate was removed by filtration. The solubility of neptunium peroxide in the $HNO_3-H_2O_2$ solution was determined. (M.C.G.)

12228 (TID-16242) THE PREPARATION AND PROPERTIES OF $NaUF_7$, Na_2UF_8, KUF_7 AND K_2UF_8. John G. Malm and Henry Selig (Argonne National Lab., Ill.). May 1962. Contract [W-31-109-eng-38]. 9p. (UAC-6473)

The reactions of UF_6 with NaF and KF were carried out in C_7F_{16}. The reaction with NaF resulted in $NaUF_7$ which is stable at room temperature but decomposes at 100°C in vacuum to give Na_2UF_8. Na_2UF_8 in turn gives off UF_6 at 300°C to leave NaF. The reaction with KF resulted in KUF_7, which similarly decomposes to K_2UF_8 at 100°C in vacuum. (D.L.C.)

12229 (TID-17008) STUDY OF APPLICATIONS OF THE MÖSSBAUER EFFECT IN SCIENCE AND TECHNOLOGY. Quarterly Progress Report for Period April 15 to July 15, 1962. L. M. Epstein (Westinghouse Electric Corp. Research Labs., Pittsburgh). Aug. 1962. Contract AT(30-1)-2989. 29p. (WERL-62927-11506-R1)

Seven ferroin type compounds were examined on the Mössbauer velocity spectrometer in an effort to correlate the isomer shift with the degree of covalency. Fairly narrow doublets centered at 0.3 to 0.5 mm/sec were characteristic of the phenanthroline complexes in the form of their perchlorate salts. A magnetically modulated 14-kev gamma ray source and synchronous detector were constructed for studying some of the parameters of the proposed scheme of modulated gamma ray detection. Successful operation was demonstrated at a modulation frequency of 3 cps. Schematics of the equipment and discussion of results are included. (D.C.W.)

12230 (TID-17638) HIGH TEMPERATURE OXIDATION AND NITRIDATION OF NIOBIUM IN ULTRAHIGH VACUUM. Quarterly Report No. II, September 1 to November 30, 1962. R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). Dec. 13, 1962. Contract AT (04-3)-115. 17p.

Extensive testing of the ultrahigh vacuum unit is described in which a pressure in the 10^{-10} torr range was attained. Other work was directed toward a numerical evaluation of the theoretical concepts on which the experimental approach is based. It is noted that the focus of interest in the program is the adsorption-controlled mechanism associated with gas-niobium systems. Results of a literature survey on Nb–O and Nb–N systems are included. (J.R.D.)

12231 (TID-17814) DISTRIBUTION USEFUL IN TESTING FOR RANDOMNESS IN A TWO OR MULTI-PHASE STRUCTURE. G. L. Burrows (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract [W-31-109-eng-52]. 21p.

A mathematical model that describes random mixing of particulate matter is defined. Two-phase or multi-phase solids can be cut into plane section samples; the plane sections are over-layed with an appropriate grid (fixed size and shape) and an examination made of the pattern of occupied and unoccupied grid intersections. Such occupied intersections group together to form pseudo-clumps. The relative frequency of pseudo-clumps of various sizes

was tabulated for random mixing and serves as a useful guide to determine if relatively large clumps occur more frequently than would be produced under random mixing. The method can also be used on exposed surfaces of loose-mixed powders. (H.G.G.)

12232 (TID-17828) THERMODYNAMIC PROPERTIES OF SOLID SOLUTIONS AT HIGH TEMPERATURES. Progress Report, December 16, 1962–January 25, 1963. Arnulf Muan (Pennsylvania State Univ., University Park. Coll. of Mineral Industries). Contract AT(30-1)-2781. 44p.

Activity-composition curves for cobalt oxide and manganese oxide in $(Co,Mn)_3O_4$ solid solutions with spinel type structure have been determined by studying the distribution of cations between the spinel phase and a coexisting (Co,Mn)O solid solution phase in the temperature range 1100–1400°C. Within limits of experimental error, the system displays the behavior of a regular solution. The excess integral free energy of mixing is represented by the equation $\Delta F^{Ex} = -5520\ N_{Co} \cdot N_{Mn}$. The standard free energy of formation of cobalt manganite, $CoMn_2O_4$, from the oxide components CoO and Mn_2O_3 was calculated to be −8.6 kcal. (auth)

12233 (JPRS-17403) OXIDATION OF URANIUM DIOXIDE. V. G. Vlasov and A. F. Bessonov. Translated from Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met., 5: No. 5, 113-22(1962). 13p.

Results of investigations concerning the kinetics of UO_2 oxidation in various media are presented. The effects of additions of alkali metal carbonates, ThO_2, ZrO_2, and TiO_2 on oxidation kinetics are also discussed. Phase transformation schemes for UO_2 oxidation at various temperatures are proposed. (J.R.D.)

12234 THE MECHANISM OF THE SENSITIZATION OF PHOTOGRAPHIC EMULSIONS BY TRIETHANOLAMINE. M. Nicolae and V. Labău (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 297-307(1962). (In Rumanian)

The reductive power of triethanolamine in solutions on AgBr was studied as a function of the concentration and solution pH. The difference between the mechanism of the action of the amine and that of alkalis (the action of OH ions) was shown. The mode of variation of the redox potential of the amine solutions containing AgBr in suspension and the irreversibility of the amine sensitization effect have led to the conclusion that the sensitizing effect is a function of reducing power. It follows that the effect is connected to the increase of sensitivity centers. The sensitizing effect of the amine is not connected to the effect of the pH on the sensitivity of the photographic emulsion. The dependence of the pH of the sensitizing action is explained by the variation of the reducing power of triethanolamine with the pH. (tr-auth)

12235 THE CRYSTAL STRUCTURE OF $KI \cdot Hg(CN)_2$. F. H. Kruse (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 16: 105-9(Feb. 10, 1963). (LADC-4882). (In English)

Crystals of $KI \cdot Hg(CN)_2$ are orthorhombic: $a_0 = 4.412$, $b_0 = 16.190$, $c_0 = 9.690$ Å (all ±0.004 Å), Z = 4. Of the possible space groups, $Cmc2_1$, C2cm and Cmcm, the centric group Cmcm was selected. The crystal structure was refined to R = 0.097 using Mo Kα radiation with counter data out to 2θ of 50°. Linear $Hg(CN)_2$ groups are incorporated normal to sheets consisting of iodine atoms weakly bound to the central mercury atom. The sheets are puckered at a 140° dihedral angle about the strings of iodines parallel to a_0. Each mercury atom is coordinated to four iodine atoms and conversely each iodine atom is surrounded by four mercury atoms. Hg–I bond lengths are 3.383 Å, lying between the 2.75 Å predicted for covalent single bond radii and the 3.70 Å from van der Waals contact radii. The Hg–C distance of 2.079 Å is near the 1.986 Å measured in $Hg(CN)_2$ but is shorter than 2.20 Å predicted for single bond covalent radii. Adjacent sheets are held together by the K^+ ions. (auth)

12236 THE SYNTHESIS AND CRYSTAL STRUCTURES OF SOME ALKALINE EARTH TITANIUM AND ZIRCONIUM SULFIDES. Abraham Clearfield (National Lead Co., Niagara Falls, N. Y.). Acta Cryst., 16: 135-42(Feb. 10, 1963). (In English)

Barium titanium sulfide ($BaTiS_3$) and calcium, strontium, and barium zirconium sulfides ($CaZrS_3$, $SrZrS_3$, and $BaZrS_3$) were synthesized by the reaction of CS_2 with the respective ternary oxides at elevated temperatures. Barium titanium sulfide is hexagonal but its sulfur content decreases with increasing temperature of preparation. This results in a variation of unit cell dimensions from a = 6.752, c = 5.810 Å when prepared at 700°C to a = 6.77, c = 5.74 Å when prepared at 1100°C. $BaTiS_3$ containing a stoichiometric or near stoichiometric equivalence of sulfur has the barium nickelate structure. As the sulfur content decreases the structure becomes increasingly disordered. $BaZrS_3$ is orthorhombic with a = 7.037, b = 9.983, c = 7.050 Å and has a distorted perovskite structure. $SrZrS_3$ and $CaZrS_3$ have even more highly distorted perovskite structures and require orthorhombic unit cells with a = 13.49, b = 9.79, c = 14.23 Å for $SrZrS_3$ and a = 13.07, b = 9.58, c = 14.05 Å for $CaZrS_3$. (auth)

12237 METHODS FOR THE PREPARATION OF ZnS SINGLE CRYSTALS. P. Kovács and J. Szabó (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest and Research Inst. for Scientific Information, Budapest). Acta Phys. Acad. Sci. Hung., 14: 131-44 (1962). (In German)

ZnS single crystals were prepared by the modified Frerich method as a model for the study of electroluminescence. The effect of various factors–carrier gas, flux materials, heat treatment, impurities of the initial reagents, and temperature distribution–on the size, form, and properties of the single crystals produced was tested. Relations between the impurity concentration of the initial material and that of the single crystal were considered. The crystal structure was discussed and microscopic, electron diffraction, and x-ray diffraction patterns were given. (tr-auth)

12238 PARAMETER CHANGES WITH COLD WORK IN LITHIUM FLUORIDE. D. Lewis and H. Pearson (Battersea Coll. of Tech., London). Appl. Phys. Letters, 2: 59-60 (Feb. 1, 1963).

The effects of cold ball milling and annealing of LiF on the lattice parameters are investigated. The annealing is carried out at 20 to 600°C. The variations of the x-ray scattering peak position and width with working time are discussed. It is concluded that there are two deformation processes operative in LiF. (T.F.H.)

12239 ADSORPTION CHARACTERISTICS OF ^{60}Co-IONS TOWARDS POLYSTYRENE TREATED WITH SULFURIC ACID RELATIVE TO RADIOACTIVE DECONTAMINATION. Tsutomu Seimiya and Tsunetaka Sasaki (Tokyo Metropolitan Univ.). Bull. Chem. Soc. Japan, 35: 1567-9 (Sept. 1962).

The adsorption of Co ions by polystyrene treated with sulfuric acid was measured using a radiotracer technique. The type of adsorption of the Co ions by polystyrene with or without sulfuric acid treatment was also studied by observ-

ing the rate of desorption by the use of several rinsing liquids. It was confirmed that, although Co ion adsorption on an untreated surface is much less than that on a treated surface, the former is rather harder to remove by rinsing than the latter, regardless of the nature of the rinsing liquid. (P.C.H.)

12240 DISSOLUTION AND ANION EXCHANGE BEHAVIOR OF THE RARE EARTH ELEMENTS IN POTASSIUM AND AMMONIUM CARBONATE SOLUTIONS. Tomitsugu Taketatsu (Kyushu Univ., Fukuoka, Japan). Bull. Chem. Soc. Japan, 35: 1573-6(Sept. 1962).

The amounts of rare earth elements dissolved in potassium and ammonium carbonate solutions of various concentrations were determined. The amounts increased with an increase in the concentration of the carbonate and also with an increase in atomic number, except for Ce, Y, and Sc. When the precipitates of the rare earth elements are completely dissolved in carbonate solutions more concentrated than a certain known concentration, the distribution coefficients, K_d, of the rare earth carbonate ions between an anion exchange resin of a carbonate form and potassium or ammonium carbonate solutions of various concentrations were determined. The values of K_d increased both with a decrease in the concentration of carbonate ions and with the increasing atomic number of the rare earth elements. Since the slopes of the curve $\log K_d$ vs. $\log(CO_3)^{2-}$ in a potassium carbonate solution were found to be almost the same value for all the rare earth elements investigated, it was concluded that the soluble complex of rare earth elements possesses an identical negative charge. (P.C.H.)

12241 ON THE ABSORPTION SPECTRUM OF H_2O AND D_2O IN THE VACUUM ULTRAVIOLET. J. W. C. Johns (National Research Council, Ottawa). Can. J. Phys., 41: 209-19(Feb. 1963). (NRC-7113)

The spectra of normal and heavy water vapor are observed with high resolution in the region 1220 to 1240 Å. One band of H_2O and two bands of D_2O are measured and analyzed. The spectra are taken in the ninth order of a 35-ft concave-grating spectrograph, and the accuracy of measurement of the sharper lines is estimated to be about ±0.005 Å. The observed bands are assigned as belonging to the first member of one of the two np Rydberg series. (auth)

12242 THE RELATION BETWEEN THE LIFETIME AND INTENSITY OF THE FLUORESCENCE IN THE REGION OF THERMAL EXTINCTION. Hugues Payen de la Garanderie (Laborotoire de Luminescence, Faculté des Sciences, Paris). Compt. Rend., 255: 2585-7(Nov. 12, 1962). (In French)

A more thorough study was made of one of the luminescent complexes of manganese previously described (Compt. Rend., 254: 2739(1962)) in order to verify the law of proportionality between the lifetime and the luminous yield. Some alterations to the usual method were made to show this law. (tr-auth)

12243 OXIDATION-REDUCTION REACTIONS OF COMPLEX AMMINES OF RUTHENIUM(II)-(III). John F. Endicott and Henry Taube (Stanford Univ., Calif.). J. Am. Chem. Soc., 84: 4984-5(Dec. 20, 1962).

The reductions of $[Ru(NH_3)_6]^{3+}$, $[Ru(NH_3)_5Cl]^{2+}$, and $[Ru(NH_3)_5H_2O]^{3+}$ by Cr^{2+} were found to have 1:1 stoichiometry, and the specific rates of the reductions were measured. By reoxidation of the Ru^{2+} species, it was found that the Ru^{2+}-NH_3 bonds remain intact in acid solution for at least 1 hr, and the oxidation rate with ClO_4^- was measured. The reaction $[Ru(NH_3)_5H_2O]^{3+} + Cl^- \rightarrow [Ru(NH_3)_5Cl]^{2+} + H_2O$ is catalyzed by $[Ru(NH_3)_5]^{2+}$, and the equilibrium constant was found to be 43 ± 3 at 25°C and $\mu = 0.1$. (D.L.C.)

12244 XENON HEXAFLUORIDE. J. G. Malm, I. Sheft, and C. L. Chernick (Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 110-11(Jan. 5, 1963).

The preparation and properties of XeF_6 are reported. Yields of XeF_6 of greater than 90% were obtained by heating 5.25 mmole of Xe and 110 mmole of F for 16 hr at 300°C and about 60 atm in a nickel reaction vessel. The compound is a colorless solid, with a vapor pressure of about 7.5 mm at 0°C and 30 mm at 25°C. It is stable at room temperature and reacts violently with hydrogen or water at room temperature. It dissolves without reaction in anhydrous hydrogen fluoride. The infrared spectrum of the vapor was also studied. (P.C.H.)

12245 XENON HEXAFLUORIDE. E. Eugene Weaver, Bernard Weinstock, and Charles P. Knop (Ford Motor Co., Dearborn, Mich.). J. Am. Chem. Soc., 85: 111-12(Jan. 5, 1963).

The preparation and properties of XeF_6 are reported. Reactions were carried out in a stainless steel vessel at 1000 psi and 350 to 450°C. In all cases a mixture of volatile products was obtained. The more volatile fractions always concentrated XeF_6. The purity of the samples was monitored by infrared spectroscopy. In the purest XeF_6 sample, the twin bands, $\nu_2 + \nu_3$ and $\nu_1 + \nu_3$ were observed at 1154 and 1189 cm^{-1}. The formula for XeF_6 was established by chemical analysis. The compound can be reduced with H_2 to form HF and Xe. Preliminary vapor pressure measurements gave: 0°C, 6mm; and 20°C, 27 mm. (P.C.H.)

12246 ON THE PROBABLE STRUCTURE OF XeF_4 AND XeF_2. R. E. Rundle (Iowa State Univ., Ames). J. Am. Chem. Soc., 85: 112-13(Jan. 5, 1963). (IS-580)

It is believed that the molecular structures of XeF_4 and XeF_2 may be predicted; reasons for this are given. Details of the proposed structure are illustrated and discussed. From the proposal it is expected that oxyfluorides of Xe will contain pairs of linear F–Xe–F 3c-4e bonds. (P.C.H.)

12247 CRYSTALLOGRAPHIC STUDIES OF XeF_2 AND XeF_4. Stanley Siegel and Elizabeth Gebert (Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 240(Jan. 20, 1963). (TID-17869)

The structure of XeF_2 prepared by a photochemical process is described, and crystallographic data on XeF_4 presented. XeF_2 is tetragonal with $a = 4.315 \pm 0.003$ Å and $c = 6.990 \pm 0.004$ Å. Crystals condensed from XeF_4 vapor at room temperature were found to exhibit more than one symmetry. A monoclinic form frequently observed has the dimensions $a = 5.03$Å, $b = 5.92$Å, $c = 5.79$A, and $\beta = 99^0 27'$. (M.C.G.)

12248 MOLECULAR SYMMETRY OF XeF_2 AND XeF_4. L. L. Lohr, Jr. and William N. Lipscomb (Harvard Univ., Cambridge, Mass.). J. Am. Chem. Soc., 85: 240-1(Jan. 20, 1963).

The molecular structures of XeF_2 and XeF_4 were investigated in terms of a programed semi-empirical LCAO molecular orbital theory. Sixteen electron pairs and 17 molecular orbitals were considered for XeF_2, with 23 electron pairs and 25 molecular orbitals for XeF_4. Results are presented in tabular form. (auth)

12249 THE CRYSTAL AND MOLECULAR STRUCTURE OF XENON DIFLUORIDE BY NEUTRON DIFFRACTION. Henri A. Levy and P. A. Agron (Oak Ridge National Lab., Tenn.). J. Am. Chem. Soc., 85: 241-2(Jan. 20, 1963).

A neutron diffraction study of XeF_2 at room temperature

was carried out. The tetragonal body-centered lattice indicated by preliminary x-ray precession photographs was confirmed by neutron measurements on 67 non-extinguished equivalent pairs of reflections (hkl, khl) and at positions of 53 reflections required to be absent by body centering. The symmetric linear molecules were aligned on the tetrad axes with the Xe-F distance of 1.983 (σ = 0.002)Å. (M.C.G.)

12250 CRYSTAL AND MOLECULAR STRUCTURE OF XENON TETRAFLUORIDE. David H. Templeton, Allan Zalkin, J. D. Forrester, and Stanley M. Williamson (Univ. of California, Berkeley). J. Am. Chem. Soc., 85: 242(Jan. 20, 1963).

The crystal structure of XeF_4 was determined by x-ray diffraction at room temperature. The structure consists of a molecular packing of square-planar molecules of XeF_4. The monoclinic unit cell has dimensions a = 5.050, b = 5.922, c = 5.771Å (each ±0.003Å), and β = 99.6° ± 0.1°. With 2 molecules per cell the density is 4.04 g/ml. Intensities were measured for the 329 independent reflections of the primitive cell with θ less than 25°. Of these, 36 were absent because of the space group symmetry. Calculations gave Xe–F bond distances of 1.92 and 1.90Å. (M.C.G.)

12251 ON THE MECHANISM OF THE ISOTOPIC EXCHANGE OF TRITIUM WITH METHANE. S. Wexler (Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 272-7 (Feb. 5, 1963).

The techniques of "high pressure" mass spectrometry were used to identify some of the principal ionic intermediates in the "Wilzbach labeling" of methane with T_2. In mixtures of T_2 and CH_4 the long-lived transient is $C_2H_4T^+$. This ionic species appears to be involved in the nuclear-decay-induced part of the labeling mechanism. Mixtures of D_2 (as a stand-in for T_2) and methane were irradiated with electrons to study the radiation-induced part of the mechanism. The ionic interaction transients observed were CH_4D^+, $C_2H_4D^+$, $C_2H_3D_2^+$, and $C_2H_2D_3^+$. An investigation of the scavenging by xenon was attempted by irradiating mixtures of Xe and CH_4. The results are correlated with the ionic mechanisms previously proposed for the tritium labeling of CH_4. (auth)

12252 THE NORMAL VIBRATIONAL FREQUENCIES AND THE THERMODYNAMIC FUNCTIONS OF H_2SO_4 AND D_2SO_4. Paul A. Giguère and Rodrigue Savoie (Laval Univ., Quebec). J. Am. Chem. Soc., 85: 287-9(Feb. 5, 1963).

In order to calculate the thermodynamic functions of H_2SO_4 and D_2SO_4 in the ideal gas state, the infrared spectra of the liquid and solid acids were re-examined over the whole range of fundamental vibrations, i.e., from 300 to 4000 cm^{-1}. Attempts to observe the spectrum of the vapor were unsuccessful. Corrections for the large frequency shifts due to hydrogen bonding in the condensed phases were evaluated by comparison with the spectra of related compounds, particularly the halogenated acid HSO_3F. The major uncertainty stems from the contribution of the torsional oscillations of the OH (or OD) groups which are restricted by a threefold energy barrier estimated at about 1.3 kcal. (auth)

12253 PREPARATION OF XeF_4 (XENON TETRAFLUORIDE) BY ELECTRIC DISCHARGE. A. D. Kirshenbaum, L. V. Streng, A. G. Streng, and A. V. Grosse (Temple Univ., Philadelphia). J. Am. Chem. Soc., 85: 360-1(Feb. 5, 1963).

The apparatus and conditions used in the preparation of XeF_4 by electric discharge are described. A gas mixture of 1 volume Xe 2 volumes F_2 was used, and a quantitative yield of XeF_4 was obtained. The composition of the product was confirmed by several methods. (D.L.C.)

12254 NUCLEAR SPIN RELAXATION IN LIQUID $CHFCl_2$. R. J. C. Brown, H. S. Gutowsky, and K. Shimomura (Univ. of Illinois, Urbana). J. Chem. Phys., 38: 76-86(Jan 1, 1963).

Nuclear spin relaxation times were measured for liquid $CHFCl_2$, the values of T_{1H} and T_{1F} between 132 and 298°K at 27, 20 and 17 mc, and T_{2H} and T_{2F} over the same temperature range at 20 mC. The results of the measurements are discussed, and relaxation mechanisms shown to be important are: intermolecular dipole-dipole interactions, including their effect upon the electronic, scalar coupling of the proton and fluorine nucleus; the quadrupolar relaxation of the chlorine nuclei, which are coupled to the proton and the fluorine nucleus by scalar couplings; and the spin-rotation interaction between the fluorine nucleus and the reorientation of the molecule. Statistical assumptions of rotational Brownian motion of the molecule, in the liquid, when applied to the spin-rotation interaction, were found to predict the wrong temperature dependence of T_{1F} at high temperatures. A transient rotation model is proposed in which the molecules jump from one orientation to another at random times; the spin-rotation interaction is assumed to operate during these jumps when the molecule is actually rotating. The statistical properties of such a model were calculated, and it is shown that T_{1F} is predicted to have the correct temperature dependence. The dipole-dipole and quadrupole interactions are discussed in detail, and a treatment of intermolecular dipole-dipole relaxation by Redfield's method is given, with results indicating that the electronic, scalar coupling of nuclei contributes to the inequality $T_2 < T_1$ often found in liquids. (P.C.H.)

12255 PRESSURE DEPENDENCE OF THE NMR CHEMICAL SHIFTS IN CESIUM AND RUBIDIUM HALIDES. Robert Baron (Univ. of Chicago). J. Chem. Phys., 38: 173-87(Jan. 1, 1963).

Chemical shifts, line shapes, linewidths, and line intensities were measured as a function of pressure and crystal structure from 1 to 10^4 kg/cm^2 at room temperature for both metal and halide nuclei in alkali halide pressed powder pellets. Measurements were made on Rb^{87}, Cs^{133}, Cl^{35}, Br^{81}, and I^{127} in RbCl, RbBr, RbI, CsBr, and CsI. The chemical shifts become more paramagnetic with increasing pressure within any one phase. At the transition from NaCl to CsCl-type crystal structure exhibited by the rubidium halides, the Rb^{87} chemical shifts become less paramagnetic, and the halide chemical shifts become more paramagnetic. As usual, the magnitude of the effects increases with increasing atomic number. The correction of the chemical shifts for second-order quadrupole interactions is discussed. The data are compared to chemical shifts calculated from a covalent model and an overlap model. The absolute values of the chemical shifts are in doubt. (P.C.H.)

12256 XENON DIFLUORIDE. D. F. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.). J. Chem. Phys., 38: 270-1 (Jan. 1, 1963). (TID-16931)

The preparation, purification, and identification of xenon difluoride, XeF_2, is reported. It is a colorless solid with a vapor pressure comparable to that of XeF_4, about 3 mm at room temperature. It can be sublimed easily at room temperature to give weakly birefringent rhombohedrons, along with a few three- and six-sided crystal figures. The spectrum of XeF_2 at 100°C with nearly saturated vapor pressure showed a band at 1070 cm^{-1}, with no discernible Q branch, and a P-R peak separation of 15 cm^{-1}. (P.C.H.)

12257 KINETICS OF DESORPTION. II. Cs^+ AND Ba^+ FROM RHENIUM. Milton D. Scheer and Joseph Fine (Na-

tional Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 307-9(Jan. 15, 1963).

The mean desorption lifetimes (τ_3) of Cs^+ and Ba^+ on an atomically clean rhenium surface were measured. Under conditions of low surface coverage, $\tau_3 = 1.9 \pm 0.9 \times 10^{-13}$ exp $(23{,}300 \pm 500/T)$ sec was obtained for Cs^+ in the temperature range $950 < T < 1080°K$. This is in excellent agreement with the data obtained previously for the $Cs^+ - W$ system. For Ba^+ on rhenium, $\tau_3 = 0.6 \pm 0.4 \times 10^{-13}$ exp $(54{,}700 \pm 2400/T)$ sec was obtained in the temperature range $2100 < T < 2310°K$. The $Cs^+ - Re$, like the $Cs^+ - W$ bonding, can be attributed to the electrostatic image energy of a Cs^+ ion on an electrically conducting surface. The $Ba^+ - Re$ interaction, on the other hand, must include a large exchange force in addition to the electrostatic image force because of the unpaired valence electron remaining in the univalent barium positive ion. The presence of an adsorbed layer of residual vacuum gases decreased the $Cs^+ - Re$ binding energy by 0.4 ev and increased the pre-exponential factor by two orders of magnitude. These results are almost identical with that reported previously for Cs^+ desorbing from a contaminated tungsten surface. (auth)

12258 EXCHANGE OF METHANOL BETWEEN SOLVATED CATIONS AND SOLVENT. [PART] I. J. H. Swinehart, T. E. Rogers, and H. Taube (Univ. of Chicago and Stanford Univ., Calif.). J. Chem. Phys., 38: 398-404 (Jan. 15, 1963).

The exchange of methanol between solvated Li^+, Cd^{2+}, and Mg^{2+}, and the solvent was studied by the isotope dilution technique at −82.5 and −96.9°C. Even at −96.9°C the exchange is complete for Li^+ and Cd^{2+} within the time of sampling, 0.5 min. However, the exchange for solvated Mg^{2+} is observable. At −82.5 and −96.9°C the half lives for the isotopic exchange are 3.7 and 64 min, respectively. The activation energy $\Delta H^{\ddagger}$ is 12.5 ± 2.0 kcal/mole and the entropy of activation $\Delta S^{\ddagger}$ is 4 ± 4 eu. The "kinetic solvation number" of Mg^{2+} with respect to methanol as determined by the isotope dilution technique is less than six, where six is the coordination number of Mg^{2+} in these solutions. The defect is caused by residual water which both displaces methanol from the coordination sphere and labilizes it for exchange. (auth)

12259 THE OXIDATION OF PRASEODYMIUM OXIDE. PART I. CHEMISORPTION ON PRASEODYMIUM OXIDE. J. S. Anderson and K. J. Gallagher (Univ. of Melbourne). J. Chem. Soc., 52-61(Jan. 1963).

Both type C and type A modifications of $PrO_{1.8}$ chemisorb oxygen at −196° with little or no activation energy. The amount of oxygen chemisorbed per unit surface area is greater on material of type C than on material of type A, and this difference is attributed to the high concentration of anion vacancies in the former. Anion vacancies are inherent in the type C structure but are absent from the type A structure which is close-packed. It is suggested that the extent to which type A $PrO_{1.8}$ chemisorbs oxygen is a measure of the average "defect" co-ordination number of oxygen ions around praseodymium ions on the surface. Both carbon dioxide and hydrogen are strongly bound by $PrO_{1.8}$ surfaces and are extremely difficult to remove, even at high temperatures. Their presence on the surface diminishes its chemisorptive capacity for oxygen. (auth)

12260 ORGANOSILOXY-DERIVATIVES OF METALS. PART II. TRIALKYLSILYLOXIDES OF QUINQUEVALENT AND SEXIVALENT URANIUM. D. C. Bradley, R. N. Kapoor, and B. C. Smith (Birkbeck Coll., London and Univ. of Western Ontario, London). J. Chem. Soc., 204-7(Jan. 1963).

Reaction of trialkylsilanols with uranium pentaethoxide or uranium hexaethoxide gives uranium pentakis- or hexakis-trialkylsilyloxides. The pentakistrialkylsilyloxides were prepared also from uranium pentakistrimethylsilyloxide by silanol exchange. The physicochemical properties of these compounds are compared with those of the corresponding uranium t-alkoxides and tantalum pentakistrialkylsilyloxides. The preparation of uranium hexakis-t-pentyloxide is reported. (auth)

12261 DIMETHYLALUMINIUM CYANIDE AND ITS GALLIUM, INDIUM, AND THALLIUM ANALOGUES; BERYLLIUM AND METHYLBERYLLIUM CYANIDE. G. E. Coates and R. N. Mukherjee (University Science Labs., Durham, Eng.). J. Chem. Soc., 229-33(Jan. 1963).

The cyanides $Me_2M \cdot CN$ (M = Al, Ga, In, or Tl) were prepared from the trimethylmetal and hydrogen cyanide. In contrast to the polymeric boron cyanides, $R_2B \cdot CN$, the aluminium, gallium, and indium compounds are tetrameric in benzene, and dimethylthallium cyanide is a salt in aqueous solution. Reactions between dimethylberyllium (and its trimethylamine complex) and hydrogen cyanide are also described. (auth)

12262 THE STRONTIUM OXIDE−CARBON DIOXIDE SYSTEM IN THE PRESSURE RANGE 0.3-400 ATMOSPHERES. E. H. Baker (Imperial Coll. of Science and Tech., London). J. Chem. Soc., 339-46(Jan. 1963).

The strontium oxide−carbon dioxide system was studied at pressures of carbon dioxide up to 400 atm by using pressure vessels with internal heating arrangements. For the reaction $SrCO_3(s) = SrO(s) + CO_2(g)$ in the temperature range 1149 to 1259°, the results can be expressed by the relation $\Delta G^0 = 46{,}500 - 30.36T$. The eutectic point is estimated to lie at 1270° and 1.12 atm. Above the eutectic point, the pressure−temperature relations were plotted for the binary melts in equilibrium with the solid phases. By means of thermogravimetric and quenching techniques, the temperature−composition relations were derived for the eutectic portion of the system. The eutectic composition was found to be $SrCO_3$ 79.3 and SrO 20.7 moles %. (auth)

12263 RUTHENIUM PENTAFLUORIDE AND RUTHENIUM OXYTETRAFLUORIDE. J. H. Holloway and R. D. Peacock (Univ. of Birmingham, Eng.). J. Chem. Soc., 527-30(Jan. 1963).

The preparation of ruthenium pentafluoride and oxytetrafluoride is described. The vapor pressures were measured by a static method, a diaphragm gage of high sensitivity being used. The physical constants, heats of vaporization, and entropies of vaporization were derived from the vapor-pressure data. The magnetic moments were measured over the temperature range 100 to 300°K. (auth)

12264 PHASE AND EQUILIBRIUM PRESSURE STUDIES OF THE ZIRCONIUM−TITANIUM−HYDROGEN SYSTEM. V. Y. Labaton, E. V. Garner, and E. Whitehead (United Kingdom Atomic Energy Authority, Capenhurst, Chester, Eng.). J. Inorg. Nucl. Chem., 24: 1197-1204 (Dec. 1962).

Equilibrium pressure curves were determined for the ternary zirconium−titanium−hydrogen system, based on the 55 atomic per cent alloy, between 550 and 650°C, and a tentative phase diagram was constructed for the addition of hydrogen to the alloy. A room-temperature x-ray study identified the expected phases in the ternary system isomorphous with those in the zirconium and titanium systems, and in addition a new hexagonal phase was partially characterized. (auth)

12265 POLAROGRAPHY OF INORGANIC COMPOUNDS IN ISOBUTYRONITRILE AS SOLVENT. J. F. Coetzee and J. L. Hedrick (Univ. of Pittsburgh). J. Phys. Chem., 67: 221-6(Feb. 1963).

Metal ions generally are reduced at less negative potentials in isobutyronitrile than in acetonitrile, mainly because the dielectric constant of the former solvent is lower than that of the latter. However, half-wave potentials vary somewhat for different (non-complexing) supporting electrolytes. This variation is attributed to changes in the liquid junction potential and in the stability of the ion pairs formed by a given metal with different anions. The following half-wave potentials, vs. the aqueous saturated calomel electrode, were obtained at the dropping mercury electrode in 0.05 M tetraethylammonium perchlorate as supporting electrolyte (with an asterisk denoting a reversible or near-reversible electro-reaction): lithium, −1.90 v; sodium −1.77*; magnesium, −1.68; cobalt(II), −0.60*; nickel(II), −0.33; copper(II) → copper(I), more positive than the anodic dissolution potential of mercury (+0.67); copper(I) → copper amalgam, −0.25*; silver, +0.49*. In 0.05 M tetrabutylammonium iodide as supporting electrolyte, the following half-wave potentials were obtained: sodium, −1.70; potassium, −1.77*; rubidium, −1.79*; cesium, −1.80; in 0.05 M sodium perchlorate: thallium(I) (as the nitrate), −0.24*; and in 0.10 M sodium perchlorate: oxygen, −0.70 and −1.55 v. All metal ions studied, except copper(I) and silver, have lower solvation energies in isobutyronitrile than in water. Perchloric acid gives a well defined but irreversible wave at a much less negative potential ($E_{1/2}$ = −0.62 v) than in water. The overpotential of hydrogen on mercury under polarographic conditions is approximately 0.8 v smaller in isobutyronitrile than in water, and virtually equal to the value in acetone. The effect of water on the perchloric acid and cobalt waves was determined. Halide ions, X^-, give two anodic waves at the dropping mercury electrode, corresponding to successive formation of HgX_3^- and HgX_2. Both iodide waves (in 0.05 M sodium perchlorate) are reversible, with half-wave potentials equal to −0.42 and +0.19 v, respectively. Methyl red suppressed the maxima produced by thallium(I) and silver. (auth)

12266 MECHANISM AND KINETICS OF THE OXIDATION OF GLYCEROL BY CERIUM(IV) IN SULFURIC AND PERCHLORIC ACIDS. G. G. Guilbault and W. H. McCurdy, Jr. (Princeton Univ., N. J. and Univ. of Delaware, Newark). J. Phys. Chem., 67: 283-5(Feb. 1963).

The rate of oxidation of glycerol by cerium(IV) sulfate in sulfuric acid was found to follow the rate expression: $-d[Ce(IV)]/dt = 4.0 \times 10^{-3}$ [Ce(IV)] [glycerol] at 20.0° in 2.0 F sulfuric acid, where concentrations are in moles per liter and time is in minutes. The rate also was found to be first order in perchloric acid at low acid concentrations, and inversely proportional to HSO_4^-. As in previous oxidations discussed, a prior equilibrium step is believed to occur: $Ce(SO_4)_2 + H^+ \rightleftharpoons CeSO_4^{+2} + HSO_4^-$. In perchloric acid the oxidation of glycerol by ceric perchlorate proceeds via an intermediate complex between one Ce(IV) ion and one glycerol molecule. The existence of the complex was proved independently by spectrophotometry, and the proposed mechanism fits the kinetic data. (auth)

12267 OXYGEN EXCHANGE REACTIONS OF PLUTONIUM IONS IN SOLUTION. S. W. Rabideau and B. J. Masters (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 67: 318-23(Feb. 1963). (LADC-5419)

An acceleration of the rate of exchange of solvent water oxygen with that of the plutonyl(VI) ion is observed in solutions in which the lower valent oxidation states of plutonium are present. The rates of several previously measured reactions of plutonium together with the $PuO_2^+ - H_2O$ reaction can satisfactorily account for the observed exchange measurements. The upper limit of the specific rate constant for the $PuO_2^+ - H_2O$ reaction, obtained by the differences between the observed and calculated exchange rates, was estimated to be 6.4×10^{-5} sec^{-1} in molar perchloric acid at 23°. It was shown that the fluoride ion can labilize the plutonyl(VI) oxygen with respect to exchange. A half time of about 17 hr was observed in 6.5 M HF at 23°; this is in contrast to the half time in excess of 10^4 hr found for the plutonyl(VI) – water intrinsic exchange reaction. Measurements of the oxygen-18 enrichment of plutonyl(VI) ions was made after reacidification of solutions made alkaline with sodium, ammonium, or barium hydroxides. Only with barium hydroxide, which produced an insoluble product in the alkaline medium, was exchange observed; the other bases did not form precipitates. In the formation of the plutonyl(VI) ion by the ozonization of Pu(III), it was noted that one of the oxygens is derived from the water and one from the ozone. (auth)

12268 THERMOPHYSICAL PROPERTIES OF THE LANTHANIDE OXIDES. I. HEAT CAPACITIES, THERMODYNAMIC PROPERTIES, AND SOME ENERGY LEVELS OF LANTHANUM(III) AND NEODYMIUM(III) OXIDES FROM 5 TO 350°K. Bruce H. Justice and Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). J. Phys. Chem., 67: 339-45(Feb. 1963). (TID-16519)

Heat capacities of La_2O_3 and Nd_2O_3 were determined from 5 to 350°K by adiabatic calorimetry. A complex Schottky anomaly with a maximum near 14°K was resolved from the lattice contribution and shown to rise from doubly degenerate states at 0, 21, 81, and 400 cm^{-1}, which are in sharp contrast with the assignment of Penney. The entropy (S^0), enthalpy ($H^0 - H_0^0$), and Gibbs energy function ($[G^0 - H_0^0]/T$) for La_2O_3 at 298.15°K are 30.43 cal (g.f.w. °K)$^{-1}$, 4742 cal (g.f.w.)$^{-1}$, and −14.53 cal (g.f.w. °K)$^{-1}$. The estimated entropy (S^0) of Nd_2O_3 is 37.9 cal (g.f.w. °K)$^{-1}$; the measured entropy increment ($S^0 - S_0^0$) and enthalpy ($H^0 - H_0^0$) are 35.05 cal (g.f.w. °K)$^{-1}$ and 4989 cal (g.f.w.)$^{-1}$, respectively, at 298.15°K. (auth)

12269 TOPOLOGICAL ASPECTS OF THE CONFORMATIONAL STABILITY PROBLEM. PART I. DEGENERATE ELECTRONIC STATES. Andrew D. Liehr (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem., 67: 389-471(Feb. 1963).

The topography of Jahn–Teller–Renner electronic potential energy surfaces of symmetric polyatomic systems is derived by means of group theoretic and permutational symmetry principles. Degenerate perturbation theory is utilized to obtain an explicit analytical expression of this topography. The dependence of the nuclear-electronic interaction matrix elements, which occur in the perturbation development, on the nuclear coördinates is shown to be precisely determinable by group theoretic and permutational symmetry techniques. The numerical coefficients which prefix the nuclear coördinates which appear in these interaction matrix arrays are regarded as phenomenological parameters in their subsequent topographical applications. It is demonstrated that the magnitudes of these parameters determine only the relative placements of the Jahn–Teller–Renner surface reliefs and not their basic character (in this sense, minimal and maximal domains are taken to be of the same character). The formulas derived by means of the perturbation theory (with and without the complication of spin-orbit interactions) are employed to describe the topology of the multiply degenerate elec-

tronic energy surfaces of the regular polygons (including the digon) and the regular polyhedra, as well as of a number of selected highly symmetric irregular polygons and polyhedra. The results obtained reveal a number of important maxims: (1) the Jahn–Teller–Renner behavior of a polyatomic group theoretic system is completely determined by that of its elemental subgroups (principle of mathematical inheritance); (2) isomorphous point groups exhibit isomorphous Jahn–Teller deportments (formation of Jahn–Teller families); (3) whereas the prime number groups produce a single unique Jahn–Teller–Renner topography, the non-prime number groups produce all those topographies which are required by the principle of mathematical inheritance (1) (law of prime numbers); (4) the dynamical quantization and the topography of the Jahn–Teller problem are completely specified by group theoretic and permutational symmetry precepts (symmetrical transcendence); (5) although not mathematically required, the symmetry of the stable Jahn–Teller conformation is always the highest symmetry which is yet compatible with the loss of the initial inherent degeneracy (mimimax rule); (6) the Jahn–Teller–Renner energy resolvants factor only at locations of high nuclear symmetry (factorization theorem); (7) certain nuclear structures can never be Jahn–Teller stabilized (exclusion principle); (8) it is impossible to distinguish between ordinary anharmonic elastic distortions and Jahn–Teller distortions in non-homologous series of compounds (indistinguishability theorem), (9) spin-orbit forces remove cuspidal Jahn–Teller radial electronic energy singularities for geometries less regular than the cube (spin-orbit law); (10) ionic and covalent bonding forces always produce complementary Jahn–Teller deformations, whereas conjugate hole-electron electronic configurations always produce the identical deformation, bonding forces being equal (complementarity rules); (11) pseudo-Jahn–Teller interactions make conformational isomerisms possible even for dispositions of low regularity (conformational isomerization tenet); (12) doubly degenerate electronic states possess continuous Jahn–Teller–Renner electronic energy surfaces, but triply degenerate electronic states possess disjoint electronic energy surfaces in certain directions (canon of dimensional variability); (13) tetragonal Jahn–Teller conformational interconversion takes place in two dimensions for doubly degenerate electronic states, and five dimensions for triply degenerate electronic states (doctrine of dimensional impenetrability); (14) experimental proofs of Jahn–Teller–Renner consequences can only be obtained from studies of homologous series of compounds (criterion of probity). Particular care was taken to graphically illustrate all the important consequences of the mathematical derivations, so that their chief predictions should be available to theoretician and experimentalist alike. A detailed discussion of the theoretical and experimental status of the Jahn–Teller–Renner problem is presented, and courses for future advance are signposted. A master plan is sketched for the solution of the numerous as yet unsolved theoretical and experimental Jahn–Teller–Renner puzzles. (auth)

12270 TOPOLOGICAL ASPECTS OF THE CONFORMATIONAL STABILITY PROBLEM. PART II. NONDEGENERATE ELECTRONIC STATES. Andrew D. Liehr (Mellon Inst., Pittsburgh and Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem., 67: 471-94(Feb. 1963).

The topography of electronic potential energy surfaces of polyatomic systems is derived by means of group theoretic and permutational symmetry principles. It is demonstrated that the relative placement of the surface reliefs may be perfectly specified by such principles for systems which contain sufficient numbers of identical nuclei. The results obtained reveal a number of important maxims: (1) the topography of a polyatomic electronic potential energy surface is wholly determined by that of its most symmetric hypothetical geometry (law of eurythmy); (2) given a hypothetical geometry of high group theoretic symmetry, the topographical behavior of a polyatomic electronic potential energy surface is determined entirely by that of its elemental symmetrical subgroups (principle of mathematical inheritance); (3) isomorphous group theoretical conformation exhibit isomorphous topological deportments (formation of topological families); (4) whereas the prime number group theoretic constellations produce only two distinct electronic potential energy topographies, the nonprime number constellations produce all those topographies which are required by the principle of mathematical inheritance (2) (law of prime numbers); (5) the dynamical quantization and the topography of the nuclear-electronic problem are fully specified by group theoretic and permutational symmetry precepts (symmetrical transcendance); (6) certain nuclear structures can never be topologically stabilized without external aid (exclusion principle); (7) it is impossible to distinguish between ordinary anharmonic elastic distortions and Jahn–Teller distortions in non-homologous series of compounds (indistinguishability theorem); (8) experimental proofs of Jahn–Teller–Renner consequences can be procured only from studies of homologous series of compounds (criterion of probity). Particular care was taken to illustrate graphically all important consequences of the mathematical derivations, so that their chief predictions should be available to theoretician and experimentalist alike. A detailed discussion of the theoretical and experimental status of the nuclear-electronic problem is presented, and courses for future advance are signposted. A master plan is sketched for the solution of the numerous as yet unsolved theoretical and experimental nuclear-electronic puzzles. (auth)

12271 ION BINDING IN SOLUTIONS OF CESIUM POLYACRYLATE. Leo A. Noll and S. J. Gill (Univ. of Colorado, Boulder). J. Phys. Chem., 67: 498-9(Feb. 1963).

The binding of Cs^+ ions to polyacrylate ions was investigated by neutralization of polyacrylic acid solutions with $Cs^{134}OH$ in an electrolytic apparatus. Only at neutralizations above 50% was any radioactivity carried across the frit with the polyacrylate ion. The fraction of bound Cs^+ was calculated and plotted vs % neutralization, and the curve is much lower than that for Na^+ ions. (D.L.C.)

12272 THE ACTIVITY COEFFICIENTS OF RUBIDIUM AND CESIUM FLUORIDES IN AQUEOUS SOLUTION FROM VAPOR PRESSURE MEASUREMENTS. H. Ti Tien (Eastern Pennsylvania Psychiatric Inst., Philadelphia). J. Phys. Chem., 67: 532-3(Feb. 1963).

Isopiestic measurements were made on solutions of RbF and CsF at 25°C. The calculated osmotic and activity coefficients are greater for CsF than for RbF at equal molalities, and the interpretation of the data in terms of ion-ion and ion-solvent interactions is discussed. (D.L.C.)

12273 A SECOND CRYSTALLINE PHASE OF XENON TETRAFLUORIDE. John H. Burns (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 536(Feb. 1963).

A second modification of XeF_4 was prepared by condensation from the vapor near room temperature. This modification is less stable and has a greater density than the first phase. The unit-cell dimensions are: a = 6.64 ± 0.01,

$b = 7.33 \pm 0.01$, $c = 6.40 \pm 0.01_4$ and $\beta = 92°40'\ 5''$; the probable space group is $P2_1/c$. (D.L.C.)

12274 PHASE EQUILIBRIUM RELATIONS IN THE $Sc_2O_3-Ga_2O_3$ SYSTEM. S. J. Schneider and J. L. Waring. J. Res. Natl. Bur. Std., A, 67: 19-25(Jan.-Feb. 1963).

The phase equilibrium diagram was determined for the $Sc_2O_3-Ga_2O_3$ system. A quenching furnace, wound with 60 percent Pt-40 percent Rh wire, was employed for experiments conducted at temperatures up to 1,800°C. An induction furnace, having an iridium crucible susceptor, was used to obtain higher temperatures. Temperatures in the quenching furnace were measured with both an optical pyrometer and a 95 percent Pt-5 percent Rh versus 80 percent Pt-20 percent Rh thermocouple. The melting point of Ga_2O_3 was determined as 1,795 ± 15°C. Experiments at temperatures as high as 2,405°C failed to melt Sc_2O_3. Two intermediate binary phases, a compound believed to be $6Sc_2O_3 \cdot 5Ga_2O_3$ and a solid solution occur in the system. The solid solution phase appears as a single phase in the region roughly defined by the compositional limits of 55 to 73 mole percent Ga_2O_3 at the solidus. The 6:5 compound, stable only at high temperatures, melts incongruently at 1,770 ± 15°C and decomposes below 1,700 ± 15°C. The compound appears to have orthorhombic symmetry with a = 13.85 A, b = 9.80 A, and c = 9.58 A. The indicated uncertainties in the melting points are a conservative estimate of the overall inaccuracies. (auth)

12275 ON THE STRUCTURE OF BERYLLIUM HALIDES IN CONCENTRATED AQUEOUS SOLUTION. Ya. S. Bobovich. Opt. Spectry. (USSR) (English Transl.), 13: 382-3(Nov. 1962).

Raman spectra of concentrated aqueous solutions of beryllium chloride and bromide have been obtained. The highly diffuse character of the bands has been established. The conclusion is drawn that the structure of the beryllium halides is polymeric. The hypothesis is expressed that the polymerization of the molecules is brought about by donor-acceptor interaction of beryllium and halogen. (auth)

12276 DETECTION OF THE K^{40} ISOTOPE USING OPTICAL ALIGNMENT OF THE ATOMS. E. B. Aleksandrov and V. A. Khodovoi. Opt. Spectry. (USSR) (English Transl.), 13: 424(Nov. 1962).

Detection of K^{40} from its resonance in a natural mixture of potassium isotopes is accomplished by recording the resonance through optical means. The method seems applicable to detection of impurities of one alkali metal or isotope in others. (D.C.W.)

12277 ELECTRON SPIN RESONANCE ON Mn IN GaAs. R. Bleekrode, J. Dieleman, and H. J. Vegter (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 2: 355-6(Nov. 1962). (In English)

Electron spin resonance measurements were carried out on a single crystal of partly compensated p-type GaAs doped with Mn. Spectra are shown at 77°K for four different values of θ, where θ is the angle between the static magnetic field and a cubic axis. The spectra are interpreted using a spin-hamiltonian, and the A- and g-values are evaluated. (H.D.R.)

12278 MEASUREMENT OF THE CRYSTAL FIELD GRADIENT AT THE NUCLEUS OF THREE LANTHANUM SALTS. D. T. Edmonds (Oxford Univ.). Phys. Rev. Letters, 10: 129-31(Feb. 15, 1963).

Crystal field gradients at the nucleus of lanthanum ethyl sulfate, lanthanum magnesium nitrate, and lanthanum trichloride are measured using a self-quenching superregenerative frequency-modulated nuclear magnetic resonance spectrometer at 6.5 Mc/sec to obtain the resonance spectrum. Measurement of the frequency of the nuclear resonance of Li^7 with a frequency counter provides a simultaneous measurement of the field. Crystal field gradients and antishielding factors are given. The antishielding value obtained explains the large negative value of crystal field gradient observed in europium ethyl sulfate. (D.C.W.)

12279 DIRECT EVIDENCE FOR THE PRESENCE OF DELAYED RECOMBINATION IN THE ELECTROLUMINESCENCE OF ZnS. J. Kubátová and K. Pátek (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Phys. Status Solidi, 2: K265-71(1962). (In English)

The primary and secondary peaks in an electroluminescent light wave in different parts of a ZnS crystal was studied to provide data for an explanation of the mechanism of the processes in one barrier. The electroluminescence was excited by square-wave voltage pulses of alternating polarity. The results show that the emission is concentrated in two peaks-one primary and one secondary-which however occur for voltage peaks possessing different polarity. A whole series of intermediate cases is also found. The voltage dependence of the local brightness is approximately equal to that of the total brightness. If there are several radiating stripes in the space between electrodes, their polarity as a rule alternates. A rectifying barrier may arise at a boundary between pure and doped material. The results confirm the idea of the periodic broadening of the barrier regions under the action of the external field. The processes occur in the following sequence: barrier broadening with formation of ionized activators in the barrier from voltage pulse in reverse direction, barrier narrowing to equilibrium width, exposure of ionized activators to current of returning electrons, recombination with rise of secondary emission peak, and combination of electrons with ionized activators from voltage pulse in forward direction which gives rise to primary peak. (J.S.R.)

12280 LUMINESCENT PROPERTIES OF ZnS PHOSPHORS PREPARED AT ROOM TEMPERATURE. E. Lendvay, J. Schanda, K. Richter, P. Kovács, and M. Somogyi (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest). Phys. Status Solidi, 2: K272-3 (1962). (In English)

ZnS phosphors prepared from solutions of ZnS salts at room temperature and atmospheric pressure, regulating the rate of nucleation and growth, exhibited intense luminescence. Phosphors prepared by the Ortmann method exhibited luminescence only after about a year. The emission of the two phosphors shows distinct differences. The ZnS prepared by the authors has a very wide emission band covering the whole visible spectral range. A change in the relation between the bands makes it possible to change the color of the emitted light from white to bluish or reddish, suggesting that the radiation consists of broad structureless bands. The Ortmann ZnS contains only one band. (J.S.R.)

12281 A NEW BAND SYSTEM IN CdH and CdD. M. Aslam Khan (Univ. of Karachi, W. Pakistan). Proc. Phys. Soc. (London), 80: 1264-8(Dec. 1962).

A new band system in CdH and the corresponding band system in CdD have been observed in the ultraviolet region of the spectrum. The P head of the (0,0) band of the system of CdH is found to be at 2483.09 Å. The transition is classified as $c^2\Sigma \rightarrow x^2\Sigma$. As the band system appears only in absorption and not in emission at low pressures, and also as the band lines are very diffuse, it is evident that the upper state of the molecule is predissociated. The following con-

stants have been calculated: $B_0'' = 6.00\ cm^{-1}$, $\nu_{00} = 40314.85\ cm^{-1}$, $\omega' = 1674.0\ cm^{-1}$, and $\omega'x' = 53.7\ cm^{-1}$. (auth)

12282 COORDINATION NUMBER AND VALENCE IN MODERN STRUCTURAL CHEMISTRY. Robert E. Rundle (Iowa State Univ., Ames). Record Chem. Progr. (Kresge-Hooker Sci. Lib.), 23: 195-221(Dec. 1962). (IS-478)

G. N. Lewis' valence theory is described briefly. A detailed discussion is presented on the apparent violations of Lewis' rare gas rule by incomplete shells and overcomplete shells, and on valence and coordination number in the transition metal compounds. (D.L.C.)

12283 THE PHYSICAL NATURE OF THE CHEMICAL BOND. Klaus Ruedenberg (Ames Lab., Ames, Iowa). Revs. Modern Phys., 34: 326-76(Apr. 1962). (IS-106)

The quantum mechanical wave functions of molecules are discussed. An attempt is made to effect a simultaneous regional and physical partitioning of the molecular density, the molecular pair density, and the molecular energy, in such a way that meaningful concepts can be associated with the density and energy fragments thus formed. The origin of chemical binding is interpreted in terms of the concepts formulated in the partitioning process. (T.F.H.)

12284 XENON HYDROXIDE: AN EXPERIMENTAL HAZARD. N. Bartlett and P. R. Rao (Univ. of British Columbia, Vancouver). Science, 139: 506(Feb. 8, 1963).

A 0.39-g sample of xenon tetrafluoride dissolved in 1.5 ml of distilled water reacted vigorously and left a white solid. The solid detonated when warmed under vacuum above 30 or 40°C and completely shattered the enclosing vessel. (P.C.H.)

12285 RELATIVE INTENSITY OF THE α- AND γ-SYSTEMS OF THE ZrO BANDS. F. S. Ortenberg (Inst. of Thermal Physics, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 588(Jan.-Feb. 1962).

Calculations for the relative vibrational probabilities for the α and γ systems of the ZrO molecular bands were given in the light of new electronic constants and values for internuclear distances. (C.E.S.)

12286 TRANSITION PROBABILITY IN MOLECULAR ENCOUNTERS. PART 5. VIBRATIONAL-ROTATIONAL ENERGY TRANSFER. T. L. Cottrell and A. J. Matheson (Univ. of Edinburgh). Trans. Faraday Soc., 58: 2336-41 (Dec. 1962).

Vibrational relaxation times in CH_4, CD_4, SiH_4, and SiD_4 at 298 and 348°K were measured by the ultrasonic method. The deuterated molecules showed longer relaxation times than the unsubstituted molecules, and an explanation of this in terms of vibrational-rotational energy transfer is suggested. A similar explanation is offered for the existence of a separate line for hydrogen-containing molecules in the Lambert-Salter correlation plot for relaxation times. (auth)

12287 KINETICS OF ISOTOPIC EXCHANGE REACTIONS. PART 7. ELECTRON EXCHANGE BETWEEN COBALTIC HEXAMMINE AND COBALTOUS AMMINES. N. S. Biradar, D. R. Stranks, and M. S. Vaidya (The University, Leeds, Eng.). Trans. Faraday Soc., 58: 2421-32(Dec. 1962).

Direct electron tunneling between the hexammines of Co^{II} and Co^{III} is hindered by the large energy required for prior rearrangement of the primary co-ordination spheres. Electron exchange proceeds through the reaction of the $Co(NH_3)_6^{3+}OH^-$ ion pair with cobaltous ammines, $Co(NH_3)_n^{2+}$, from n = 3 to n = 6. For this reaction, irrespective of the particular cobaltous ammine, $k = 0.34 \pm 0.01$ liter $mole^{-1}$ min^{-1} at 64.5°C, $E_{act} = (12.6 \pm 1.6)$ kcal $mole^{-1}$ and $\Delta S^{\neq} = -(35 \pm 5)$ cal/mole deg. Electron transfer is shown to occur via a bridged-transition state leading to hydroxide substitution of the new Co^{III} species. Electron exchange also occurs through the $Co(NH_3)_6^{3+}Cl^-$ ion pair for which $k = 0.044 \pm 0.007$ liter $mole^{-1}$ min^{-1} at 64.5°C. The electron exchange is slightly catalyzed by glass surfaces and strongly catalyzed by metals. (auth)

12288 CATALYTIC EXCHANGE OF ALKYLBENZENES WITH DEUTERIUM ON NICKEL FILMS. E. Crawford and C. Kemball (Queen's Univ., Belfast). Trans. Faraday Soc., 58: 2452-67(Dec. 1962).

The exchange of deuterium with a series of alkylbenzenes was followed using a mass-spectrometric technique on two different kinds of nickel films. On films evaporated on to glass at 0°C, exchange occurred rapidly at −10°C with most of the hydrocarbons. The hydrogen atoms in the molecules could be classified into groups according to their ease of exchange. Group A consisted of hydrogen atoms on carbon atoms α to the ring and in ring positions not ortho to a side group, group B contained atoms ortho to one side group, and group C consisted of hydrogen atoms on β and γ carbon atoms in the compounds with side groups larger than methyl. On films sintered for 30 min at 200°C, reaction occurred rapidly at 50°C; the hydrogen atoms on the α carbon atoms were the most reactive, followed by those on β and γ carbon atoms, and the atoms on the benzene rings were the least reactive. The results support the hypothesis that benzene can be π-bonded to the nickel surface in catalytic reactions and that sintering, or possibly poisoning associated with the sintering process, destroys selectively the sites where this type of adsorption takes place. (auth)

12289 STATISTICAL CALCULATION OF THERMODYNAMIC FUNCTIONS OF AN ABSORBED SUBSTANCE ON GRAPHITE. PART 1. ADSORPTION OF MONATOMIC MOLECULES ON GRAPHITE. A. V. Kiselev and D. P. Poshkus (Inst. of Physical Chemistry, Academy of Sciences, USSR and Inst. of Chemistry and Chemical Tech., Academy of Sciences, Lithuanian SSR). Trans. Faraday Soc., 59: 176-91(Jan. 1963).

In accordance with the general problem of calculating the thermodynamic functions of a substance in the adsorbed state proceeding only from the properties of the adsorbent and adsorbate taken separately, the chemical potential, total energy, and entropy of argon adsorbed on graphite are calculated. The computation is based on evaluation of the potential energy of the argon molecule at the graphite surface taking into account the contribution of dispersion forces of attraction in the form of two terms, and the contribution of the repulsion forces in the exponential form. Interactions between the adsorbate molecule and the carbon atoms in the lattice were found by summing them up with respect to all the lattice atoms; the dispersion attraction constants were computed from the polarizabilities and magnetic susceptibilities of the adsorbate and adsorbent atoms. Then, using molecular statistic methods the partition function of the adsorbate in the classical approximation, and its thermodynamic functions were calculated, and corresponding approximate corrections were made for the quantum state of the adsorbate. The assumption that the adsorbate molecule vibrates harmonically at right angles to the surface is a good approximation. The theoretically calculated changes in chemical potential, total energy, and entropy of argon are close, within the limits of possible computation errors, to the measured heat of adsorption and to the corresponding values of the changes in thermodynamic functions evaluated from experimental data for graphitized carbon blacks. (auth)

12290 THE PARAHYDROGEN CONVERSION ON NEODYMIUM OXIDE. D. R. Ashmead, D. D. Eley, and R. Rudham (Univ. of Nottingham, Eng.). Trans. Faraday Soc., 59: 207-15(Jan. 1963).

The parahydrogen conversion and hydrogen-deuterium equilibration reaction on neodymium oxide were investigated over the temperature range 77 to 642°K. It was established that the parahydrogen conversion proceeds by a paramagnetic mechanism at low temperatures and by a chemical mechanism at high temperatures. The results are discussed and compared, where relevant, with results that have been obtained on dysprosium, gadolinium, and erbium oxides. (auth)

12291 DETERMINATION OF COMPLEX COMPOSITION BY ISOMOLAR SERIES AND EQUILIBRIUM SHIFT METHODS USING TAGGED METALS. A. K. Babko and M. I. Shtokalo (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 293-301(1962). (In Russian)

The composition of Zr complex with DM (diantipyrinemethane) in equilibrium with zirconium xylenol orange was studied using the equilibrium shift method in 1n HCl. The component ratio in the complex Zr·DM = 1:3. The ratio of Zr:DM in 0.05n HCl using zirconium eriochromocyanin complex and determined by isomolar series and equilibrium shift methods was 1:2. (R.V.J.)

12292 SPECTROPHOTOMETRIC STUDIES OF NIOBIUM PYROGALLOL COMPLEXES. A. K. Babko and V. V. Lukachina (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 371-7(1962). (In Russian)

Absorption spectra of Nb pyrogallol complexes were studied as functions of pH and concentration. An equilibrium shift analysis indicated formations of a pyrogallol complexes $NbOPg_2^-$, with λ_{max} = 360 mμ at pH 6.3, and NbO_2Pg^- with λ_{max} = 320 mμ at higher pH. Formal dissociation constants of pyrogallol niobium complexes were estimated. (R.V.J.)

12293 PREPARATION OF PrS AND NdS. G. V. Samsonov and S. V. Radzikovskaya (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 444-5(1962). (In Russian)

Descriptions are given of PrS and NdS preparation in a vacuum using the reaction $2\,Me_2S + Me_2O_3 + 3C = 6\,MeS + 3CO$. Sesquisulfides were developed by passing at ~0.2 l/min, hydrogen sulfide over Pr_6O_{11} and Nd_2O_3 specimens in a furnace heated to 1000 to 1100°C. The sesquisulfides were used as intermediate products in preparing monosulfides: $Pr_6O_{11} + 6Pr_2S_3 + 11C = 18\,PrS + 11\,CO$ and $Nd_2O_3 + 2Nd_2S_3 + 3C = 6NdS + 3CO$. The stoichiometric compositions of the monosulfides were PrS–Pr–81.46%, S 18.54%; NdS–Nd–81.82%, S 18.8%. (R.V.J.)

12294 PARTIAL VAPOR PRESSURE OF BERYLLIUM CHLORIDE MIXED WITH SODIUM AND POTASSIUM CHLORIDES. I. N. Sheiko and V. G. Feshchenko (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 478-83(1962). (In Russian)

Investigations of $BeCl_2$ vapor pressure and $BeCl_2$–NaCl and $BeCl_2$–KCl partial pressure indicate a linear dependence of lg P on 1/T. The $BeCl_2$ partial pressure in NaCl $BeCl_2$ is higher than in KCl–$BeCl_2$, and the stability of K_2BeCl_4 is higher than Na_2BeCl_4. Calculations of NaCl–$BeCl_2$ and KCl–$BeCl_2$ activity coefficients at 400°C showed that $BeCl_2$ activity is higher in NaCl–$BeCl_2$ than in KCl–$BeCl_2$. (R.V.J.)

12295 STUDIES OF INDIUM OXALATES. L. I. Dubovenko. Ukr. Khim. Zh., 28: 682-7(1962). (In Russian)

Isomeric series and equilibrium shift methods revealed the formation of indium monoxalate, $InC_2O_4^+$, in indium–oxalate systems at pH <4. Dissociation constants for dioxalate and trioxalate complex ions are $K_2 = 5.92 \times 10^{-5}$ and $K_3 = 7.31 \times 10^{-2}$, respectively. The complete dissociation constant for coordinately saturated $In(C_2O_4)_3^{3-}$ is 2.12×10^{-12}. (R.V.J.)

12296 PURIFICATION OF Ga, In, AND Tl FROM Hg, Cd, AND Zn IMPURITIES BY DISTILLATION IN HIGH-TEMPERATURE VACUUM. A. A. Shokol and L. F. Kozin (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 699-702 (1962). (In Russian)

Separation of Ga, In, and Tl from Hg, Cd, and Zn by volatilization in a vacuum at high temperature was studied. Spectral and calorimetric analyses carried out following 4-hour exposures to high temperature in a vacuum revealed no traces of Hg, Cd, or Zn. (R.V.J.)

12297 THE CHEMISTRY OF THE RARE EARTH SILICIDES. G. V. Samsonov (Inst. of Cermets and Special Alloys, Ukrainian Academy of Sciences, SSR). Usp. Khim., 31: 1478-95(Dec. 1962). (In Russian)

The physical and chemical properties of the silicides can be varied over wide limits because of the simultaneous presence of covalent bonding between the silica atoms, and metallic bonding between the metal and silica atoms. Available data on the rare earth silicides including the scandium and yttrium silicides are summarized. The structure, lattice parameters, melting points, electrical resistance, Hall coefficients, and thermal emf's are presented in tabular form. The heat of formation was estimated as +25 ± 10 kcal/atom of Si, or about 50 kcal/mol. The variation in properties with temperature is presented. For example, $LaSi_2$ is a metallic, n-type conductor from 20 to 500°C, but becomes a p-type, semiconductor above 500°C. Preparative methods can be grouped as follows: direct reaction of the rare earth metal with silicon metal, reduction of a rare earth oxide with silicon metal, and electrolysis of a fused salt containing a rare earth metal and silicon. Direct synthesis of the silicide from the elements must be carried out in an inert atmosphere due to the high affinity of rare earth metals for oxygen and nitrogen. Reduction of a rare earth oxide with silicon metal is the most widely used method. The reaction is ordinarily carried out in an aluminum oxide crucible which is heated in a graphite resistance furnace. The electrolysis method is hardly used, because it is difficult to obtain the pure silicides by this method. The available data on the silicides of Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, and Yb are given in separate sections. (33 references.) (TTT)

12298 ELECTROMETRIC STUDY ON THORIUM POLYMOLYBDATES AS A FUNCTION OF THE pH. Ram Sahai Saxena and M. L. Mittal (Government Coll., Kota, India). Z. Physik Chem. (Frankfurt), 34: 319-27(Oct. 1962). (In English)

The formation and composition of thorium polymolybdates obtained by the interaction of thorium nitrate and different alkali molybdates (normal, di, para, tri, and meta) were investigated by means of glass electrode titrations between the reactants at different pH ranges, in aqueous and aqueous-alcoholic media, with each of the reagents alternately used as the titrant. The sharp inflections in pH titration curves provide definite evidence for the formation of normal molybdate $ThO_2 \cdot 2MoO_3$ at pH range 4.2 to 5.8 and paramolybdate $ThO_2 \cdot 4.66\ MoO_3$ at pH range 3.0 to 3.75. The precipitation of normal thorium molybdate is almost quantitative and glass electrode titrations offer a simple

means of determination of thorium or molybdate solutions at suitable concentrations and pH ranges. H^+ ion concentration plays an important role in the aggregation process. (auth)

12299 INFRARED SPECTRA OF THORIUM CARBONATE COMPLEXES. A. V. Karyakin and M. P. Volynetz (Vernadskii Inst. of Geochemistry and Analytical Chemistry, USSR). Zh. Strukt. Khim., 3: 714-18(1962). (In Russian)

Infrared spectroscopy and $Na_4[Th(CO_3)_4] \cdot Na_2CO_3 \cdot 12H_2O$ were used in experiments carried out to confirm the suggested thorium carbonate complex structure: $Me_4[Th(CO_3)_4] \cdot Me_2CO_3 \times nH_2O$ (where Me = Na^+ and K^+). The presence of CO_3^{2-} in the coordination bond and free CO_3^{2-} in the outer sphere of the $Na_4[Th(CO_3)_4] \cdot Na_2CO_3 \cdot 12H_2O$ was discovered. The infrared spectra of complex absorption in vaseline and fluorine oils were measured at wave lengths of 400 to 4000 cm^{-1}. The CO_3^{2-} absorption band of hydrated $Na_4[Th(CO_3)_4] \cdot Na_2CO_3 \cdot 12H_2O$ coincided with that of $CO_3^{2-}[Co(NH_4)_4CO_3]$. (R.V.J.)

12300 STRUCTURE OF URANYLS AND THEIR ANALOGS. M. E. Dyatkina and Yu. N. Mikhailov (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 3: 724-47(1962). (In Russian)

Studies of uranyl structure indicated a strong bond UO_2^{2+} group due to the short U–O bond distance, high valence oscillation frequencies, and diamagnetic susceptibility of UO_2 to alloys in the equatorial plane. Theoretical aspects of UO_2 structure are analyzed using the valence bonding and molecular orbits. Electronic configurations of other actinide groups are also described. (tr-auth)

12301 VAPOR PRESSURES OF HAFNIUM(IV) IODIDE, TUNGSTEN(VI) CHLORIDE AND ARSENIC(III) OXIDE BY A METAL DIAPHRAGM TECHNIQUE. Franklin Dee Stevenson. Thesis, Corvallis, Ore., Oregon State Univ., 1962. 185p.

A vapor pressure apparatus, based on the metal diaphragm principle, was constructed for use at temperatures up to 700 to 800°C and pressures ranging from a few millimeters of mercury to 2 to 3 atmospheres. The rate of approach to equilibrium conditions may also be observed with the apparatus. The vapor pressure of high purity As(III) oxide was measured over the temperature interval 253 to 481°C and established the reliability of the apparatus for vapor pressure measurements. The vapor pressure data of WCl_4 were measured between 187 and 325°C and tended to agree with previous results, particularly at temperatures below the melting point. By vapor pressure measurements between 263 and 406°C, three stable forms of Hf(IV) iodide were identified (α, β, and γ modifications) in addition to a metastable form that transformed slowly at temperatures in the vicinity of 300°C to the γ modification. The vapor pressures and related thermodynamic properties of each modification were determined. An apparatus was prepared for making thermal analysis studies of hygroscopic systems of small sample size. The melting and transition temperatures of the three compounds were measured with the apparatus and compared with values obtained from vapor pressure data. Also, a comprehensive bibliography of metal halide and oxyhalide vapor pressures was prepared (302 references). From this bibliography, a tabulation was made of the vapor pressure references for each of the metal halides (listed by metal) for which actual experimental data are reported. (P.C.H.)

12302 ISOTOPIC STUDIES OF BORON HYDRIDES. Richard Egidio Enrione. Thesis, Bloomington, Ind., Indiana Univ., 1962. 64p.

Three reactions of boron hydrides were studied with the use of deuterium. At temperatures between 70 and 90°C and at a pressure of 240 mm, diborane-6 and deuterodiborane-6 were pyrolyzed and the rate of hydrogen or deuterium evolution was measured. The activation energies were 23.5 kcal/mole for diborane-6 and 28.3 kcal/mole for deuterodiborane-6. The rate of decomposition of diborane-6 was five times greater than that of deuterodiborane-6. Calculations were made to determine the relative concentrations of hydrogen- and deuterium-substituted intermediates involving both one and three boron atoms. The reaction of diborane-6 with parahydrogen and deuterium was also studied. The nature of the reaction was such that a mechanism could not be readily deduced. The reaction took place on the walls of the vessel, but was inhibited by the simultaneous and more rapid coating of the walls with decomposition products. The reaction between acetonitrile and selectively deuterated decaborane-14 was studied by measuring the isotopic content of the evolved hydrogen. On the basis of the data, certain limitations could be applied to any proposed mechanism. During the course of the reaction, exchange of hydrogen occurred among most or all of the ten positions around the top of the decaborane-14 molecule. The presence of deuterium molecules in the evolving gas indicated that both atoms are probably eliminated from the positions that participate in the exchange. (P.C.H.)

12303 OKIS' BERILLIYA SBOISTVA I PRIMENENIE. (Beryllium Oxide — Properties and Applications). R. A. Belyaev. Moscow, Gosatomizdat, 1962. 239p.

The preparation, properties, and uses of beryllium oxides are reviewed. Technology, thermodynamics, and toxicology of BeO are analyzed as well as radiation effects and nuclear properties. Extensive references are given at the end of each chapter. (R.V.J.)

12304 IMPROVEMENTS RELATING TO HYDROUS OXIDE SOLS. Frederick Troupe Fitch, Moises Gali Sanchez, and Milton Charles Vanik (to W. R. Grace and Co.). British Patent 905,919. Sept. 12, 1962. Filed June 9, 1960.

The hydrous oxide sols were prepared by rapidly mixing a sol of mixed thoria-urania particles with a sol of freshly prepared silica particles without allowing the mixture to remain at the iso-electric point for an appreciable time. The amount of silica was sufficient to change the charge on the thoria-urania particles from positive to negative. The resulting particles were stabilized with a small amount of sodium or other alkali metal hydroxide. (C.E.S.)

12305 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF PLUTONIUM. Roland Taylor and John Syme Nairn (to United Kingdom Atomic Energy Authority). British Patent 915,888. Jan. 16, 1963. Filed Jan. 29, 1960.

A process was described for the production of plutonium metal comprising the step of electrolyzing a solution of plutonium trifluoride or trichloride in a fluoride melt at a decomposition potential in the range 5 to 5.3 v. (C.E.S.)

12306 IMPROVEMENTS IN OR RELATING TO GAS PURIFICATION. (to Gesellschaft für Linde's Eismaschinen Aktiengesellschaft Zweigniederlassung Hollriegelskreuth). British Patent 916,212. Jan. 23, 1963. Priority date June 25, 1958, Germany.

A process was described for the removal by sorption of a trace impurity from a carrier gas or radioactive noble gases from a carrier gas. (C.E.S.)

12307 METHOD OF PREPARING ZIRCONIUM PHOSPHATE. Bror Borge Skytte Jensen and Ernst Thomas Rosenberg (to Atomenergikomissionen). British Patent 916,550. Jan. 23, 1963. Priority date Feb. 17, 1960, Denmark.

A method of preparing zirconium phosphate was described. Ammonium zirconium carbonate complex or an alkyl ammonium zirconium carbonate complex was reacted in solution with an ammonium phosphate, an alkyl ammonium phosphate, or a phosphoric acid. Carbon dioxide and ammonium or alkylamine were gradually removed from solution during the process thereby precipitating zirconium phosphate. (C.E.S.)

12308 IMPROVEMENTS IN THE MANUFACTURE OF ZIRCONIUM OXIDE. John Kenneth Olby (to Associated Lead Mfg. Ltd.). British Patent 918,374. Feb. 13, 1963. Filed May 24, 1960.

A process for manufacturing phosphorus-free zirconium oxide from zircon ore was described. The ore was converted to sodium or potassium zirconyl silicate by sintering with a stoichiometric quantity or a slight excess of sodium or potassium carbonate. The silicate was extracted with a solution of sodium or potassium hydroxide thereby removing phosphorus as soluble sodium or potassium phosphate. The silicate was converted to zirconyl chloride by hydrochloric acid and zirconyl chloride into zirconium oxide by treatment with sulfuric acid followed by calcination of the resulting precipitate. (C.E.S.)

Organic Chemistry

12309 (IDO-11001) ORGANIC COOLANT ESSENTIAL DATA FOURTH QUARTERLY REPORT, JANUARY 1 TO MARCH 30, 1962. J. A. Ellard, C. D. King, M. V. Milnes, W. J. Moodie, and W. H. Yanko (Monsanto Research Corp. Dayton Labs., Ohio). Apr. 6, 1962. Contract AT(10-1)-1088. 15p.

Activities in a program to obtain thermodynamic, physical, and heat transfer data on biphenyl are reported. Experimental methods for determining fundamental data on isomeric terphenyls and other selected coolants were also investigated. Biphenyl PVT measurements were completed to 525°C. Tentative values were determined. Expressions for biphenyl vapor viscosity and thermal conductivity in the low-pressure region were derived. Physical property studies were continued on the isomeric terphenyls, and purification of ortho- and meta-terphenyls via fractional crystallization is in progress. (J.R.D.)

12310 ISOLATION, AMINO ACID COMPOSITION AND SOME PHYSICO-CHEMICAL PROPERTIES OF THE PROTEIN DEUTERIO-PHYCOCYANIN. Donald S. Berns, Henry L. Crespi, and Joseph J. Katz (Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 8-14(Jan. 5, 1963). (TID-17096)

The isolation and purification of a fully deuteriated protein, deuterio-phycocyanin, from blue-green algae grown autotrophically in 99.8% D_2O is described. Sedimentation behavior in the ultracentrifuge shows the protein to be a system of reversibly interacting components. The amino acid compositions of ordinary and deuterio-phycocyanin isolated from Plectonema calothricoides were established and it appears that the amino acid compositions are identical within experimental error. Ordinary and deuterio-phycocyanin therefore probably differ only in isotopic composition. Thermal denaturation of ordinary and deuterio-phycocyanin, both dissolved in H_2O was studied by measuring the quenching of fluorescence. Deuterio-phycocyanin undergoes thermal denaturation at a temperature 5° lower than ordinary phycocyanin. Since the two proteins appear to differ primarily in the isotopic composition of the non-polar side chains, differences in denaturation behavior are probably to be ascribed to differences in hydrophobic bonding. (auth)

12311 BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE AT THE α-CARBON OF ETHYL CINNAMATE AND CERTAIN RELATED COMPOUNDS. Mary F. Zinn, Thomas M. Harris, Douglas G. Hill, and Charles R. Hauser (Duke Univ., Durham, N. C.). J. Am. Chem. Soc., 85: 71-3 (Jan. 5, 1963).

Deuterations of ethyl cinnamate, ethyl β-phenylcinnamate, chalcone, and trans-cinnamonitrile were effected with deuterioethanol by means of a catalytic amount of sodium ethoxide. The first three reactions were shown to involve replacement of the α-vinyl hydrogen by deuterium, and the last was assumed to occur similarly. trans-Cinnamonitrile afforded a mixture of the cis and trans isomers. Two possible mechanisms are considered. (auth)

12312 DEUTERIUM ISOTOPE EFFECTS IN TRANSAMINATION: L-ALANINE AND PYRIDOXAL. M. I. Blake, F. P. Siegel, J. J. Katz, and M. Kilpatrick (Univ. of Illinois, Chicago and Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 294-7(Feb. 5, 1963). (TID-16896; UAC-6676)

The reaction between pyridoxal and L-alanine at 100° depends on pH, the nature and concentration of added buffer constituents and metal ions. For the solvent H_2O, L-protio-alanine reacts with pyridoxal 2.4 times faster than the L-deuterio-alanine. For the solvent D_2O in similar buffer systems, L-protio-alanine reacts 2.9 times faster than L-deuterio-alanine. (auth)

12313 KINETIC ISOTOPE EFFECTS IN THE PYROLYSIS OF CYCLOPROPANE AND CYCLOBUTANE. Sidney W. Benson and Prakash S. Nangia (Univ. of Southern California, Los Angeles). J. Chem. Phys., 38: 18-25(Jan. 1, 1963).

An analysis of the recent kinetic isotope effects in the pyrolysis of cyclopropane and cyclopropane-d_6 is shown to be in excellent agreement with the diradical path for the reaction. This is true at the high-pressure limit and possibly near the low-pressure limit for the reaction. Using the same transition state for the isomerization with a structure about half-way between trimethylene and propylene and containing a bridged H atom, led to a frequency factor for the high-pressure rate constant in excellent agreement with the experimental data. It is also shown, from the examples of the C_2H_6 and H_2O_2 pyrolyses that secondary isotope effects may have temperature coefficients as large as or larger than those associated with primary isotope effects. Extending the same type of analysis to cyclobutane pyrolysis led to an excellent a priori calculation of the frequency factor for the high-pressure rate constant and of the kinetic isotope effects in cyclobutane-d_8. The use of group additivity relations in kinetics was explored and is shown to lead to excellent predictions in the reactions of isotopically labeled species with different isotopic content. (P.C.H.)

12314 ON THE ISOMERIZATION OF ISOBUTYL RADICALS. J. R. McNesby and W. M. Jackson (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 692-3(Feb. 1, 1963).

An experimental assessment was made of the competition between isomerization of a deuterium-labeled isobutyl radical, $(CH_3)_2CDCH_2 \rightarrow (CH_3)_2CCH_2D$, and the straight decomposition, $(CH_3)_2CDCH_2 \rightarrow CH_3 + CH_3CD = CH_2$. It was found that the first reaction was never more than 1% as rapid as the second, up to 540°C. Therefore, the only measurable unimolecular reaction of isobutyl up to 540° is the straight decomposition reaction. (auth)

12315 SYNTHESIS AND PROTON MAGNETIC RESONANCE SPECTRUM OF DEUTERATED γ-PICOLINE. D. P. Biddiscombe, E. F. G. Herington, I. J. Lawrenson, and J. F. Martin (National Chemical Lab., D.S.I.R., Middlesex, Eng.). J. Chem. Soc., 444-8(Jan. 1963).

Deuterated γ-picoline was prepared by catalytic exchange between γ-picoline and deuterium oxide. The proton magnetic resonance spectrum of a nearly fully deuterated sample was measured and compared with that of γ-picoline. From the spectra, a proton-proton coupling constant of 14.5 ± 0.4 c/sec was calculated for the methyl group and hence a value of 108.2 ± 1° for the HCH bond angle in the methyl group of γ-picoline. The spectrum also shows that deuteration proceeds more easily in the α-position than in the β-position and more easily in the ring than in the methyl group. (auth)

12316 AN INFRA-RED AND ISOPIESTIC INVESTIGATION OF THE INTERACTION BETWEEN DI(2-ETHYLHEXYL) PHOSPHORIC ACID AND TRI-N-OCTYLPHOSPHINE OXIDE IN OCTANE. H. T. Baker and C. F. Baes, Jr. (Oak Ridge National Lab., Tenn. and Texas Woman's Univ., Denton, Tex.). J. Inorg. Nucl. Chem., 24: 1277-86 (Dec. 1962).

Upon the addition of tri-n-octylphosphine oxide B, to di(2-ethylhexyl)phosphoric acid A, in octane the intensity of the phosphoryl band of A at 1232 cm^{-1} is decreased and a new band at ca. 1275 cm^{-1} appears. Detailed study of this change by Job's method of continuous variation and by the addition of B to solutions in which the total concentration of A is held constant suggested the reactions: $B + \frac{1}{2}A_2 = AB$, $Q_1 = 25 \pm 5\ M^{-\frac{1}{2}}$; $B + A_2 = A_2B$, $Q_2 = 100 \pm 50\ M^{-1}$. (The unreacted dialkylphosphoric acid is present as a dimer A_2 in octane solution). The shift in the phosphoryl band of A is consistent with H-bonded structures for A_2, A_2B, and AB. Isopiestic results appear consistent with these reactions. (auth)

12317 SOLVENTS HAVING HIGH DIELECTRIC CONSTANTS. XIII. CONDUCTANCES OF MULTIVALENT ELECTROLYTES IN N-METHYLACETAMIDE AT 40°. L. R. Dawson, J. W. Vaughn, G. R. Lester, M. E. Pruitt, and P. G. Sears (Univ. of Kentucky, Lexington). J. Phys. Chem., 67: 278-80(Feb. 1963).

The electrical conductivities of solutions of 19 multivalent electrolytes and complex salts of transition elements in N-methylacetamide (NMA) were studied at 40°. Anhydrous and hydrated salts show identical behavior within experimental uncertainty. This is interpreted to mean that in NMA the water of hydration originally associated with the solute loses its identity as such and becomes a negligible part of the solvent. Kohlrausch plots for salts of aluminum and cerium(III) exhibit pronounced maxima at low concentrations. Lesser downward inflections appear in the plots for other multivalent transition metal cations. These effects are attributed primarily to displacement reactions between the complexed cations and small amounts of strongly basic anionic ligands such as acetate ions, which occur as persistent impurities in the solvent. (auth)

12318 SOLVENTS HAVING HIGH DIELECTRIC CONSTANTS. XIV. SOLUBILITIES AND REACTIONS OF SEVERAL TYPICAL INORGANIC AND ORGANIC COMPOUNDS IN N-METHYLACETAMIDE. L. R. Dawson, J. E. Berger, J. W. Vaughn, and H. C. Eckstrom (Univ. of Kentucky, Lexington). J. Phys. Chem., 67: 281-3(Feb. 1963).

Studies of several oxidation–reduction reactions and mathematical reactions of inorganic compounds in N-methyl-acetamide (NMA) at 40° were made. In general, behavior paralleling that in water was observed. In some cases the reactions are slower in NMA. New compounds which were prepared include $AlCl_3 \cdot 6NMA$, $AlBr_2 \cdot 10NMA$, and $NMA \cdot H_2SO_4$. Solubilities of numerous inorganic and organic compounds in NMA were determined. The data provide evidence that NMA is a more "universal" solvent than is water. (auth)

12319 REACTIONS OF RADICALS. III. MEASUREMENT OF THE TRANSFER CONSTANT OF t-BUTYL PEROXIDE USING RADIOACTIVE PEROXIDE. William A. Pryor (Purdue Univ., Lafayette, Ind.). J. Phys. Chem., 67: 519-21(Feb. 1963).

The decomposition of C^{14}-labeled tert-butyl peroxide (TBP) in the polymerization of styrene in the presence of inactive azobisisobutyronitrile was investigated. The efficiency of radical production from TBP was found to be very high. (D.L.C.)

12320 STUDIES ON COORDINATION COMPOUNDS OF URANYL ACETATE WITH SOME ORGANIC COMPOUNDS. THE SYSTEM: URANYL ACETATE–RESORCINOL–WATER. C. S. Pande and S. K. Misra (Lucknow Univ., Lucknow, India). J. Prakt. Chem., 18: 237-43(Nov. 1962).

Discussion is given on whether or not resorcinol, which has the phenolic groups in the meta position, may show a tendency for complex formation with uranium. (P.C.H.)

12321 THE LUBRICATION OF EQUIPMENT WHICH IS EXPOSED TO IONISING RADIATION. Peter Michael Blanchard and Neville John Hunter (to British Petroleum Co. Ltd.). British Patent 916,999. Jan. 30, 1963. Filed Jan. 29, 1960.

High energy radiation of all types caused an increase in viscosity of lubricating fluids. Certain compounds produced by reacting low molecular weight alkyl derivatives of benzene with low molecular weight alkylene dihalides were effective radiation-resistant lubricants. The invention consisted of the use of compounds produced by reacting an aromatic compound of the formula $C_6H_{6-n}R_n$, where n is an integer from 1–5 inclusive and R was an alkyl group having 1–5 carbon atoms, with 0.5–1 times the amount, on a molar basis, of an alkylene dihalide having 1–10 carbon atoms. Preferred aromatic compounds were toluene and xylene and preferred alkylene dihalides were ethylene dichloride and ethylene dibromide. (C.E.S.)

Radiation Chemistry and Radiochemistry

12322 (ARL-90) RADIOLYSIS OF LIQUID METHANOL–INHIBITORY EFFECTS OF ADDITIVES. Weldon G. Brown and Manfred K. Eberhardt (Chicago. Univ.). Nov. 1961. Contract AF 33(616)-3875. 17p. (AD-274539)

Results of methanol radiolysis are reported in which the effects of N_2O, NO, benzene, toluene, mesitylene, benzaldehyde, pyridine, stilbene, and naphthalene were tested. (J.R.D.)

12323 (BMI-1610) RADIATION-INDUCED CHANGES IN POLYMERS AND THEIR INFLUENCE ON GRAFT POLYMERIZATION. Francis A. Sliemers, Jr., John F. Kircher, Robert Lieberman, Richard Markle, William B. Gager, Manfred Luttinger, and Robert I. Leininger (Battelle Memorial Inst., Columbus, Ohio). Jan. 22, 1963. Contract W-7405-eng-92. 36p.

The preparation and irradiation behavior of a number of polymers, particularly those of the acrylate and methacrylate families, were studied. Particular emphasis was placed on the role of structural factors and their impor-

tance in the investigation of radiation susceptibility. It was found that polymer molecular weight influences site formation. Site concentration is quite markedly affected by dose rate. Cyclization of the pendant-ester group has somewhat the same effect as has chain branching. Comparison of the EPR spectra of methacrylate polymers having cyclic ester groups with those having acrylic pendant structures suggests mechanistic differences associated with free-radical formation. Poly-2-hydroxypropylmethacrylate was examined in a continuation of investigations of structural effects and found to produce a type of EPR spectrum that would not be predicted from conventional structural considerations. In addition to an investigation of the mechanism of free-radical formation, postirradiation graft-copolymerization reactions were examined in some detail. Direct grafting methods as well as vapor-phase and peroxide-initiated copolymerizations were studied. (auth)

12324 (NYO-7987) RADIATION CHEMISTRY PROGRESS REPORT, APRIL 1, 1962–MARCH 31, 1963. Gilbert J. Mains (Carnegie Inst. of Tech., Pittsburgh). Jan. 31, 1963. Contract AT(30-1)-2007. 39p.

The presence of C_6H_5D, $C_6H_3D_3$, and C_6D_5H among the benzene products from the Hg-sensitized radiolysis of a 1:1 mixture of C_2H_2 and C_2D_2 was confirmed by low voltage mass spectrometry. The absence of benzene exchange reactions was demonstrated by the formation of C_6H_6 by irradiating C_2H_2 in the presence of Hg vapor and C_6D_6. A free radical mechanism is suggested. The radiation induced H_2-D_2 exchange is inhibited by trace amounts of Xe at 25°C as reported by Schaeffer and Thompson. At 262° Xe sensitizes the exchange rather than inhibits it. At 262°C Hg vapor also sensitizes the radiation induced exchange. A comparison study of the Hg-photosensitized exchange indicates that the exchange is heterogeneous at 25°C and that the photostationary state is both surface and pressure dependent. The Hg-sensitized photolysis and radiolysis of ethane yield qualitatively similar products at 262°C. These products differ greatly from those obtained by direct radiolysis of ethanes; an observation which implies the importance of ionic species in direct radiolysis. Although Hg-sensitized photolysis and radiolysis of ethane yield qualitatively similar products, the effect of pressure on these systems differ, the H_2-HD-D_2 distributions from the Hg-sensitized photolysis and radiolysis of a $C_2H_6-C_2D_6$ mixture are also different. It is suggested that a second excited state of Hg is responsible for these differences. A preliminary study of the Hg-sensitized photolysis and radiolysis of silane was initiated. Future research is to be directed toward a more careful study of silane-alkane systems. (auth)

12325 (RRL-100) QUARTERLY REPORT [ON RADIATION RESEARCH], OCTOBER 1, 1962–DECEMBER 31, 1962. Fundamental Research No. 6041. (Mellon Inst. Radiation Research Labs., Pittsburgh). Jan. 11, 1963. Contract AT(30-1)-2310. 16p. (NYO-10314)

Abstracts are presented of various reports which have been submitted for publication: fluorescence of cyclopentanone vapor, accurate ESR hyperfine measurements, excitation of cyanogen, photolysis of $(C_2H_5)_2CO-CCl_4$, vinyl radical, decomposition of aliphatic hydrocarbons, ignition of ethane–air, and photolysis of iodoethane. Summaries are also presented for other investigations in progress on the radiolysis of liquid olefins, gaseous vinyl chloride, tertiary amino compounds, liquid benzene, aqueous benzene solutions, aqueous isopropyl alcohol solutions, and aqueous aldehyde solutions. (D.L.C.)

12326 (TID-17508) THE ANALYSIS OF POLYPHENYL RADIOLYSIS PRODUCTS BY GAS CHROMATOGRAPHY AND OTHER METHODS. W. W. West (California Research Corp., Richmond). Oct. 22, 1962. Contract AT(04-3)-248. 40p.

A description is presented of useful chromatographic techniques for analysis of polyphenyl radiolysis products. Included are details of column construction and packing, column packing effectiveness comparisons, chromatograph operating conditions, retention times for radiolysis products, and sample introduction techniques. (J.R.D.)

12327 SYNTHESIS OF HIGH SPECIFIC ACTIVITY C^{14}-CARBOXYL INDOLEACETIC ACID AND OF C^{14}-NITRILE INDOLEACETONITRILE. Bruce B. Stowe (Yale Univ., New Haven). Anal. Biochem., 5: 107-15(Feb. 1963).

Existing methods that can be modified for the synthesis of C^{14} carboxyl-labeled indoleacetic acid were surveyed and the conditions necessary to obtain the maximum radiochemical yield from C^{14}-cyanide were determined. A major problem is the autoradiosensitivity of the product, which can be minimized by storage in dilute acetonitrile solution. Detailed procedures are given for a convenient one-day synthetic method for high purity indoleacetic acid and indoleacetonitrile with sufficient specific activity for use at physiological concentrations. The former was prepared with specific activities up to 16.9 mC/mmole. At the highest specific activity levels, autoradiodecomposition during the course of synthesis apparently limits the yield obtained. (P.C.H.)

12328 THE CHEMICAL EFFECTS OF IONIZING RADIATION ON NON-METALLIC CRYSTALS. A. J. Forty (Univ. of Bristol, Eng.). Brit. J. Appl. Phys., 14: 3-9(Jan. 1963).

Structural and chemical changes occur in many different inorganic solids as a result of irradiation. Radiation damage produced by low-energy electron bombardment or irradiation with x rays and ultraviolet light occurs predominantly through atomic and ionic processes induced by ionization. Some observations on the manner in which certain substances decompose in ionizing radiations, on the form taken by the products of decomposition, and on the ways in which these are accommodated in the parent crystal are described. Attempts to provide mechanisms for these processes are discussed. Ionization displacement of ions in the solid appears to be an important factor in all of these. The details of this form of interaction are not clearly understood for any system at present, but various possibilities are presented. (auth)

12329 RECOIL REACTIONS IN IRRADIATED TRIS-(NITROSONAPHTHOLATO)- AND TRIS-(DIMETHYLGLYOXIMATO)-COBALT(III) COMPLEXES. Nobufusa Saito, Takeshi Tominaga, and Hirotoshi Sano (Tokyo Univ.). Bull. Chem. Soc. Japan, 35: 1739-40(Oct. 1962).

Recoil reactions of Co^{60} were investigated in tris-(α-nitroso-β-naphtholato)-, tris-(β-nitroso-α-naphtholato)-, and tris-(dimethylglyoximato)-cobalt(III) complexes. The percentages of Co^{60} activity separable as Co(II) for samples irradiated and stored for varied times are tabulated. Nitrosonaphtholato-cobalt(III) complexes showed considerably lower percentages for the Co(II) fraction. The α-nitroso-β-naphtholato-complex represented higher extractability of Co^{60} as Co(II) than the β-nitroso-α-naphtholato-complex. It is suggested that this might possibly be related to some differences in configuration of their ligands or chemical properties of the complexes. (P.C.H.)

12330 HOMOGENEOUS CATALYSIS OF RADIOLYTIC OXIDATIONS BY OSMIUM TETROXIDE IN AQUEOUS

SOLUTION. Moiese Haiessinsky and Jean-Claude Dran (Institut du Radium, Paris). Compt. Rend., 255: 2438-9 (Nov. 5, 1962). (In French)

A study was made to determine the effect of OsO_4 on the radiolytic yield of Te^{4+} and H_2O_2 in the γ radiation of sodium tellurite in acid solution. It was determined that the variation of the catalyst concentration in a ratio of 1 to 5 does not modify the radiolytic results. The catalyst permits not only the oxidation of Te^{4+} by the H_2O_2, but at relatively high concentration, a better utilization of the free radicals OH and HO_2. The oxidation yield in the presence of OsO_4 is higher than the sum $G(Te^{6+}) + G(H_2O_2)$ measured in its absence. OsO_4 causes, without radiation, the stoichiometric oxidation of Te^{4+} by H_2O_2. When acid solutions of Te^{4+} are irradiated in the presence of H_2O_2 alone, the concentration of the latter increases slowly, whereas the oxidation yield is considerably reduced. In the presence of OsO_4, the H_2O_2 disappears rapidly. (J.S.R.)

12331 CHANGES OF SPECIFIC HEAT OF γ-IRRADIATED PERSPEX. S. Faggiani and M. Serra (Istituto di Fisica Technica, Facoltà di Ingegneria, Rome). Energia Nucl. (Milan), 10: 47-8(Jan. 1963). (In English)

An adiabatic microcalorimeter was used to investigate the changes of the specific heat of Perspex (methyl methacrylate polymer), which are due to a weak gamma irradiation. After specimens were machined, their specific heat was measured during a long time interval. Irradiation was started only when stability was reached, and it lasted 66 hours. It was found that the specific heat of Perspex undergoes a fairly large initial decrease owing to irradiation and subsequently increases up to a value which is still lower than the one before irradiation. (M.C.G.)

12332 RELATION BETWEEN THE DIELECTRIC LOSS AND THE OXIDATION OF IRRADIATED POLYETHYLENE. Hiroshi Sasakura (Industrial Research Inst., Osaka). Japan. J. Appl. Phys., 2: 66-7(Jan. 1963). (In English)

Infrared measurements showed no difference between the formation of carbonyl groups in gamma-irradiated high-density and low-density polyethylenes. On the other hand, dielectric measurements showed a remarkable difference between the irradiated polyethylenes. It is concluded that the dielectric loss in irradiated polyethylene is chiefly due to the carbonyl group formed in the amorphous region. (D.L.C.)

12333 SOLUTE-SOLVENT INTERACTIONS IN THE RADIOLYSIS OF ALKYL HALIDE–PENTANE SOLUTIONS. Paul R. Geissler and John E. Willard (Univ. of Wisconsin, Madison). J. Am. Chem. Soc., 84: 4627-33(Dec. 20, 1962). (TID-16276)

The G values for production of methyl, ethyl, propyl, and pentyl radicals by the radiolysis of 0.25 mole % solutions of iodine in pentane are reduced by the presence of methyl iodide, ethyl iodide, or normal propyl bromide at concentrations in the range of 1%, except for the radical representing the hydrocarbon fragment of the alkyl halide. The latter is produced with high yield. The total G (radicals) is increased from 8.2 to about 11.6 by the halide additives. The presence of normal propyl chloride does not produce these effects. Studies of the fate of $C^{14}H_3$ radicals produced in the radiolysis of $C^{14}H_3I$ solutions in pentane and of the fate of I^{131} from similar $C_2H_5I^{131}$ solutions were used to examine further the solute–solvent interactions during radiolysis. The evidence indicates that the reaction $RI + e^- \rightarrow R + I^-$ must play a significant role in such systems and supports the conclusion that neutralization of RH^+ ions by negative ions is less apt to lead to radical production than neutralization by electrons. Electron capture and any other indirect processes which may lead to $C^{14}H_3$ production during radiolysis of solution of $C^{14}H_3I$ in pentane increase in yield with increasing concentration below about 0.8 mole % and remain constant at higher concentrations, indicating that all available electrons and other radical producing species react with the halide at this concentration. Iodine production occurs during the radiolysis of ethyl iodide pentane solutions in which only 10% of the energy is absorbed by the ethyl iodide. This reflects solute–solvent interactions since G (radicals) in the radiolysis of pentane is 8.2 while $G(\frac{1}{2}I_2)$ in the radiolysis of C_2H_5I is 4.2. (auth)

12334 PHASE DEPENDENCE OF CARBON-11 RECOIL PRODUCTS IN ETHANE AND PROPANE; EVIDENCE FOR METHYLENE INSERTION. Gerhard Stoecklin and Alfred P. Wolf (Brookhaven National Lab., Upton, N. Y.). J. Am. Chem. Soc., 85: 299-30(Jan. 20, 1963).

It is shown that the recoil product spectrum from C^{11} reactions with ethane is gas and liquid phases and from propane in gas, liquid, and solid phases is dependent on the phase. The $C^{12}(n,2n)C^{11}$ reaction was used to produce the C^{11} recoils. The change from gas to liquid phase caused a drop in the sum of ethylene and acetylene yields in both ethane and propane. A further decrease in these yields was observed for solid propane. An increase in 3 carbon compounds for ethane and 4 carbon compounds for propane was found when the phase was changed. Yields were in agreement with predictions based on the de-excitation and methylene insertion hypothesis. (M.C.G.)

12335 NEUTRON ACTIVATION AS A METHOD FOR LABELLING THE PHOSPHORUS OF NUCLEOTIDES. R. J. Young and H. G. Khorana (Univ. of Wisconsin, Madison). J. Am. Chem. Soc., 85: 245(Jan. 20, 1963).

Neutron activation was used to label the phosphorus of nucleotides. Adenosine triphosphate was irradiated in the water-cooled compartment of a graphite reactor at a neutron flux of 6.5×10^{11} neutrons/cm^2/sec for 62 hours. There was found to be extensive decomposition localized exclusively in the radioactive molecule. Only a small fraction of the radioactive phosphorus was found to be associated with nucleotides. (M.C.G.)

12336 RECOMBINATION AND DISPROPORTIONATION REACTIONS OF IODINE ATOMS AND ETHYL RADICALS. J. A. Guercione and M. H. J. Wijnen (Mellon Inst., Pittsburgh). J. Chem. Phys., 38: 1-3(Jan. 1, 1963). (RRL-88; Nyo 10309)

The photolysis of various mixtures of diethyl ketone and methyl iodide was investigated in order to obtain information regarding disproportionation and recombination reactions of ethyl radicals and iodine atoms. Ethyl radicals, produced by photolysis of diethyl ketone, react with iodine atoms, produced by photolysis of methyl iodide, according to reactions $C_2H_5 + I \rightarrow C_2H_4 + HI$ and $C_2H_5 + I \rightarrow C_2H_5I$. The results indicate $k_{13}/k_{14} = 0.33 \pm 0.03$. The influence of added gas and the effect of temperature are discussed. (auth)

12337 RECOMBINATION AND DISPROPORTIONATION REACTIONS OF MONOCHLOROETHYL AND TRICHLOROMETHYL RADICALS. B. C. Roquitte and M. H. J. Wijnen (Mellon Inst., Pittsburgh). J. Chem. Phys., 38: 4-7(Jan. 1, 1963). (RRL-85; NYO-10306)

The recombination and disproportionation reactions of CH_2CH_2Cl and CCl_3 radicals were investigated. Trichloromethyl radicals and monochloroethyl radicals were produced by photolyzing carbon tetrachloride in the presence of ethylene. The reaction mechanism is given along with the rate constants. (P.C.H.)

12338 GAS-PHASE RADIOLYSIS OF ISOBUTANE. R. P. Borkowski and P. J. Ausloos (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 36-44 (Jan. 1, 1963).

The radiolysis of $(CH_3)_3CD-I_2$ and $(CH_3)_3CH-(CD_3)_3CD-I_2$ mixtures was investigated as a function of pressure (0.2 to 75 cm) and temperature (30 to 225°C). Propane, which is the major product, is mostly formed by a hydride transfer reaction such as sec-$C_3H_7^+ + (CH_3)_3CH \rightarrow C_3H_8 + (CH_3)_3C^+$. From the distribution of the isotopic propanes produced in the radiolysis of $(CH_3)_3CD$, it was concluded that hydrogen atoms in the sec-propyl ion are randomized in various degrees depending on the pressure of isobutane. Ethane is mainly formed by a hydride transfer reaction $C_2H_5^+ + (CH_3)_3CH \rightarrow C_2H_6 + C_4H_9^+$. Two distinct processes lead to the formation of ethylene, molecular elimination from isobutane, and reaction of vinyl ions with isobutane. The effect of xenon, krypton, and argon on the product distribution and the randomization of the sec-propyl ion are discussed in some detail. (auth)

12339 INHIBITION OF THE ARGON-SENSITIZED RADIOLYSIS OF PROPANE BY HYDROGEN. Jean H. Futrell and Thomas O. Tiernan (Aeronautical Research Labs., Wright-Patterson Air Force Base, Ohio). J. Chem. Phys., 38: 150-4(Jan. 1, 1963).

Argon sensitizes the radiolysis of propane, presumably by dissociative charge transfer. Hydrogen interferes with the sensitization reaction by serving as a scavenger for Ar^+ according to the reaction $Ar^+ + H_2 \rightarrow ArH^+ + H$. Sensitization and self-inhibition by hydrogen were also considered, and approximate values of the sensitization rate constants were derived from a study of the inhibition processes. (auth)

12340 ELECTRON SPIN RESONANCE IN AN IRRADIATED SINGLE CRYSTAL OF TETRAMETHYL AMMONIUM CHLORIDE. A. J. Tench (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 38: 593-6(Feb. 1, 1963). (BNL-6402)

An analysis of the electron spin resonance spectrum of γ-irradiated crystals of $N(CH_3)_4Cl$ shows that the paramagnetic species stable at room temperature is $(CH_3)_3N^+$. The isotropic coupling constants are found to be 18.0 G for the nitrogen and 26.7 G for the methyl protons. All methyl protons are found to be equivalent. The radical is probably planar and is found to execute restricted rotation at room temperature. (auth)

12341 ESR SPECTRUM OF THE CYCLOHEXADIENYL RADICAL. Richard W. Fessenden and Robert H. Schuler (Mellon Inst., Pittsburgh). J. Chem. Phys., 38: 773-4 (Feb. 1, 1963). (RRL-91; NYO-10310)

The ESR spectrum of liquid 1,4-cyclohexadiene was observed during irradiation with 2.8-Mev electrons. The hyperfine interactions of seven protons indicate that the radical is a planar, conjugated π radical. Assignments are made for the coupling constants. The results are compared with these found for irradiated solid benzene. (D.L.C.)

12342 RADIATION CHEMISTRY OF CARBOHYDRATES. PART XII. ACTION OF IONISING RADIATIONS ON AQUEOUS SOLUTIONS OF D-MANNITOL. G. O. Phillips (University Coll., Cardiff, Eng.). J. Chem. Soc., 297-303(Jan. 1963).

When oxygenated D-mannitol solutions are exposed to ionizing radiations, the initial product is D-mannose. Initial G(D-mannose) is the same for fast electrons, Co^{60} γ radiation, and 190 kv radiation (G 2.25); initial $G(H_2O_2)$ is 3.0. A radical mechanism is proposed which is in fair agreement with the overall stoichiometry. The results indicate that oxygenated D-mannitol solutions may be a convenient dosimeter for ionizing radiations up to a dose rate of ca. 1.7×10^{18} ev min^{-1} ml^{-1}. (auth)

12343 RADIATION CHEMISTRY OF ISOTACTIC AND ATACTIC POLYPROPYLENE. I. GAS EVOLUTION AND GEL STUDIES. W. Schnabel and M. Dole (Northwestern Univ., Evanston, Ill.). J. Phys. Chem., 67: 295-9(Feb. 1963).

A study was made of gas evolution and gel formation when both atactic and isotactic polypropylene are irradiated by Co-60 γ rays in vacuo at room temperature. The G-value for hydrogen evolution, 2.7, is somewhat less than for polyethylene, while $G(CH_4)$ is 0.08. The gas from the irradiation of atactic polypropylene contained more methane and less hydrogen than that from the isotactic sample. The gel data can be interpreted on the basis of the Charlesby–Pinner gel equation, but very low values for cross-linking are obtained. It is concluded that the cross-linking G-value, G(X), lies between 0.068 and about 0.3, that G(X) for isotactic polypropylene is about 0.6 that of atactic polypropylene, that most of the hydrogen evolution results in double bond formation or possibly intramolecular cross-linking, and that G(S) is practically identical for atactic and isotactic polypropylene. These conclusions are for G-values beyond the gel point and are estimated assuming constancy of G-values with dose. (auth)

12344 RADIATION CHEMISTRY OF ISOTACTIC AND ATACTIC POLYPROPYLENE. II. INTRINSIC VISCOSITY STUDIES. R. W. Keyser, B. Clegg, and M. Dole (Northwestern Univ., Evanston, Ill.). J. Phys. Chem., 67: 300-3 (Feb. 1963).

The intrinsic viscosity of irradiated isotactic and atactic polypropylene was measured over the γ-ray dose range 0 to 5.7×10^{20} ev g^{-1} for irradiations in vacuo followed by annealing. The data can be accurately expressed by the empirical equation $\ln [\eta]_r/[\eta]_0 = Aq + Bq^2$, where q is the square root of the dose and A and B are constants. This equation also is applicable to data for other branched polymers. It is shown that $(d \ln [\eta]/dq) = (ad \ln b/dq) + (d \ln K/dq) + \ln M_w(da/dq) + (4aM_w/100N_A)[G(X) - G(S)/2b)]q$, where a and K are the constants of the Mark-Houwink viscosity equation and b is the weight to number average molecular weight ratio. With the Inokuti equations of the previous paper it is possible to give a roughly quantitative interpretation of the viscosity data assuming that initially G(S) is about 1.2 and then drops to about 0.18 by the time that the gel point is reached. (auth)

12345 ABSORPTION SPECTRA IN IRRADIATED WATER AND SOME SOLUTIONS. [PART I]. ABSORPTION SPECTRA OF 'HYDRATED' ELECTRON. J. W. Boag (Mount Vernon Hospital, Northwood, Middx, Eng.) and Edwin J. Hart. Nature, 197: 45-7(Jan. 5, 1963).

The absorption spectra of aqueous solutions after exposure to a pulse of 1.8 Mev electrons reveal a broad transient absorption band that is believed to be due to the hydrated electron, the existence and properties of which are predicted by Platzman. Aqueous ammonia solutions of various concentrations are exposed to 1.8 Mev electrons and their absorption spectra observed. The transient spectrum observed is assumed to be due to an electron trapped in the water. (D.C.W.)

12346 ABSORPTION SPECTRA IN IRRADIATED WATER AND SOME SOLUTIONS. [PART II]. OPTICAL ABSORPTIONS IN IRRADIATED WATER. J. P. Keene (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature, 197: 47-8(Jan. 5, 1963).

Results of irradiating water with 5000 rads/pulse and using a steady light source with a photocell to obtain a cathode-ray oscilloscope trace showing optical absorption are examined. Cherenkov light produced during the pulse affected apparent transmission, sending it above 100% in some instances. Observations are made on the absorbing substance and its removal from the water. (D.C.W.)

12347 THE EXTRACTION OF AMERICIUM AND EUROPIUM NITRATES BY TRI-n-OCTYL PHOSPHINE OXIDE IN TOLUENE. Tomitaro Ishimori (Japan Atomic Energy Research Inst., Tokyo), Chin Taik Rhee, and Takeo Fujino. Nippon Genshiryoku Gakkaishi, 4: 837-44(Dec. 1962). (In English)

The extraction behavior of americium and europium is studied in TOPO (tri-n-octylphosphine oxide) nitric acid system. The distribution ratios (K_d values are measured as functions of nitric acid, hydrogen ion, nitrate ion, and TOPO concentration. The results lend support to the conclusion that only free TOPO extracts smericium and/or europium. By using this conclusion, the maximal K_d value and corresponding acidity are estimated. The peak positions of K_d for the extractions of thorium and zirconium are also studied in this system. These values are consistent with experimental values. (auth)

12348 YIELD AND DEGREE OF CONTAMINATION IN THE SEPARATION OF IODINE-132 FROM TELLURIUM-132 BY DISTILLATION AND COLUMN CHROMATOGRAPHY. W. Boerner, W. Hamann, and E. Moll (Universität, Wurzburg, Ger.). Nucl. Med., 3: 118-19(1962). (In German)

In tests of the radiochemical purity of I^{132} separated from Te^{132} by column chromatography, the I^{131} admixture underwent only slight variations from charge to charge, whereas the Te^{132} concentration varied considerably and was undetectable in some charges. To clarify this variation, a series of separated I^{132} samples was analyzed with respect to purity by studying the first elution and a second elution 14 days later. The I^{131} fraction was the same order of magnitude in both samples, but no detectable Te contamination was found. It was assumed that the high Te contamination found in some parts of the column could be traced back to the properties of the Al_2O_3 powder. (J.S.R.)

12349 THE DECOMPOSITION OF AROMATIC SUBSTANCES BY DIFFERENT KINDS OF RADIATION. PART 2. THE RADIOLYSIS OF BENZENE, BIPHENYL, AND ORTHOTERPHENYL WITH PARTICLES FROM THE $^{10}B(n,\alpha)$ REACTION. W. G. Burns and C. R. V. Reed (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Faraday Soc., 59: 101-11(Jan. 1963).

Benzene, biphenyl, and orthoterphenyl were irradiated with particles from the $B^{10}(n,\alpha)$ reaction by exposing dilute solutions of boron compounds to thermal neutrons in the BEPO pile. The product yield per unit mass of the substance irradiated for a given thermal neutron dose was a linear function of the boron concentration, indicating additivity of the effects of the background pile radiation and the induced nuclear reaction. G values for the $B^{10}(n,\alpha)$ particles calculated from the slopes of the linear graphs were essentially the same for two different boron compounds. Values at 25°C for benzene were $G(H_2) = 0.57$, $G(C_2H_2) = 0.26$, $G(-C_6H_6) = 2.1$, and there was little variation with temperature up to 80°C. G values for biphenyl at 100°C were $G(H_2) = 0.17$, $G(-C_{12}H_{10}) = 1.52$, and for orthoterphenyl at 80-100°C, $G(H_2) = 0.19$, $G(-C_{18}H_{14}) = 0.93$. All these values are greater than those for fast electrons by factors ~10 or more, except for $G(-C_6H_6)$, which is greater by a factor ~2. G values for the pile radiation, obtained using previous calorimetric data, were intermediate between those for fast electrons and those for the $B^{10}(n,\alpha)$ particles. The large variations in G(–M) for biphenyl and orthoterphenyl are attributed to the competing reactions of excited molecules rather than radicals. (auth)

12350 THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. II. THE BLEACHING OF OXYGEN-CONTAINING METHYLENE BLUE SOLUTIONS WITH 50 kv X RADIATION IN THE PRESENCE OF AROMATIC CARBOXYLIC ACID AND ESTERS. Nikolaus Rakintzis, Werner Kunz, and Dietrich Schulte-Frohlinde (Kernforschungszentrum Karlsruhe, Ger.). Z. Physik. Chem. (Frankfurt), 34: 51-7(Sept. 1962). (In German)

The velocity of radiation chemical bleaching of aqueous oxygen-containing methylene blue solutions was measured in dependence on the concentration and composition of the aromatic carboxylic acids and esters added. Carboxylic acids show, even at low concentrations, a saturation of the protective effect, that is, the velocity of the bleaching was independent of the concentration of the protective material. The saturation effect is however dependent on the redox potential of the protective material and on the pH. Hamamelitannin possesses a special protective effect. Its protective effect depends linearly on the concentration, shows no saturation effect, and at high concentrations exceeds that of thiourea. In oxygen-free solutions those substances that have the quinoid group have special protection effects. (tr-auth)

12351 PHOTOLYTIC AND RADIOLYTIC DECOMPOSITION OF ETHYLIODIDE IN THE GASEOUS PHASE. Ralph Schindler and M. H. J. Wijnen (Mellon Inst., Pittsburgh). Z. Physik. Chem. (Frankfurt), 34: 109-12(Sept. 1962). (In German)

The decomposition of C_2H_5I through light absorption and from bombardment with fast electrons was investigated in the gaseous phase. The volatile decomposition products were determined by gas chromatography, and hydrogen and methane were determined by mass spectroscopy. Only the ethylene and ethane formation is considered. The results showed that ethylene is formed in a process in which no radicals participate. In radiolysis ethylene formation is not reduced by radical captors, but in photolysis it was repressed. The probable mechanism for ethane formation was discussed. (J.S.R.)

12352 PROCESS FOR THE SEPARATION OF METAL IONS AND MEANS FOR CARRYING OUT THE PROCESS. (to South African Council for Scientific and Industrial Research). British Patent 914,004. Dec. 28, 1962. Priority date Apr. 3, 1958, South Africa.

A process was provided for separating or concentrating ions from fission products and other solutions. In particular the process provided a means for separating or concentrating radioactive cesium from acid fission product solutions and enabled cesium to be obtained free from other metal ions, including other alkali metal ions. (C.E.S.)

12353 IMPROVED APPARATUS FOR GENERATING NUCLEAR FISSION PRODUCTS. Frank Harlen (to Dowty Electrics Ltd.). British Patent 915,861. Jan. 16, 1963. Filed Nov. 14, 1957.

An apparatus of comparatively small size for generating nuclear fission products was described. The main purpose of this apparatus was to facilitate testing of the detection instruments used with gas-cooled reactors for detecting broken fuel elements by coolant contamination. (C.E.S.)

12354 GRAFT COPOLYMERS. (to Rohm and Haas Co.). British Patent 916,217. Jan. 23, 1963. Priority date May 8, 1958, United States.

Novel graft copolymers and their preparations were described. Specific monomers were grafted onto particular, preformed polymers by means of high-energy irradiation. The monomers and polymers used were known compounds. Unique graft copolymers were obtained in substantially quantitative amounts. (C.E.S.)

12355 PROCESS FOR SEPARATING AMERICIUM AND CURIUM FROM RARE EARTH ELEMENTS. R. D. Baybarz and M. H. Lloyd (to U. S. Atomic Energy Commission). U. S. Patent 3,079,225. Feb. 26, 1963.

This invention relates to methods of separating americium and curium values from rare earth values. In accordance with the invention americium, curium, and rare earth values are sorbed on an anion exchange resin. A major portion of the rare earth values are selectively stripped from the resin with a concentrated aqueous solution of lithium chloride, and americium, curium, and a minor portion of rare earth values are then stripped from the resin with a dilute aqueous solution of lithium chloride. The americium and curium values are further purified by increasing the concentration of lithium chloride in the solution to at least 8 molar and selectively extracting rare earth values from the resulting solution with a monoalkylphosphoric acid. (AEC)

12356 PRODUCTION OF TRITIUM. Glenn H. Jenks, E. M. Shapiro, N. Elliott, and C. V. Cannon (To U. S. Atomic Energy Commission). U. S. Patent 3,079,317. Feb. 26, 1963.

This invention relates to a process for the production of tritium by subjecting comminuted solid lithium fluoride containing the lithium isotope of atomic mass number 6 to neutron radiation in a self-sustaining neutronic reactor. The lithium fluoride is heated to above 450°C. in an evacuated vacuum-tight container during radiation. Gaseous radiation products are withdrawn and passed through a palladium barrier to recover tritium. (AEC)

Raw Materials and Feed Materials

Refer also to abstracts 12061 and 12062.

12357 (BM-RI-6173) RECOVERY OF BERYLLIUM FROM SPOR MOUNTAIN, UTAH, ORE BY SOLVENT EXTRACTION AND CAUSTIC STRIPPING. Laird Crocker, R. O. Dannenberg, D. W. Bridges, and J. B. Resenbaum (Bureau of Mines. Salt Lake City Metallurgy Research Center). June 1962. 30p.

A study of Be recovery from sulfate leach liquor by di-2-ethylhexyl phosphate (EHPA) solvent extraction in conjunction with caustic stripping is described. The work was one phase of Bureau of Mines research on process development for Spor Mountain, Utah, ores. Solution for the solvent extraction studies was prepared by H_2SO_4 leaching of ore containing 0.6% BeO. Before solvent extraction of Be, the leach liquor was treated to prevent coextraction of Fe by either removal of ferric iron by amine solvent extraction or reduction of ferric iron to nonextractable ferrous iron by treatment with SO_2. Be was extracted from the aqueous leach liquor by countercurrent multistage contacting with a kerosene solution of EHPA. The loaded organic solution was stripped with NaOH solution. Subsequently, BeOH was precipitated by boiling the sodium beryllate strip solution and converted to BeO of 98% BeO-grade by calcining. Material of this grade can be directly processed into Be–Cu alloy or be used as starting material for further refining to produce high-purity, nuclear-grade Be. Over 90% of the Be contained in the leach liquor was recovered as BeO. (auth)

12358 STUDY OF THE ISOTOPIC RATIO U^{234}/U^{238} IN AQUEOUS EXTRACTS FROM URANIUM–PHOSPHATE–ZIRCONIUM ORES WITH CONSIDERATION OF THEIR FORMATION. N. G. Syromyatnikov and I. I. Tolmachev. At. Energ. (USSR), 13: 600-2(Dec. 1962). (In Russian)

It was noted previously that the U^{235}/U^{238} activity ratio which is equal to about 1 in rocks and minerals, becomes larger than 1 in liquid ore extracts. The value of the ratio depends on the degree of dispersion of the U in the ore, the size of the microcracks, and the extractability of U. Extracts of primary U ores may reach a value of 10. Relatively high values of the ratio were found also in U-containing Zr-phosphate ores. The ratio was determined in several ores, not containing primary U minerals, the U being associated with fluorapatite. The ground ores were exposed to Na_2CO_3 solution, removing subsequently the U extraction with ether and determining the ratio from the α and β activities. In extracts from phosphatic rocks the ratio varied from 1.8 to 2.5, remaining independent from the U content within the range from 0.01 to 0.12% U. In the phosphate–Zr ores the ratio reached values ranging from 2.5 to 5.7 in the hydrothermal and metasomatic rocks. At U contents above 0.1% the ratio in the extract rose with the increasing U content of the ore. A similar correlation was noted between the ZrO_2 content and the ratio in the extract. Study of the ratio may help to determine the genesis of the rock. (TTT)

12359 THE URANIUM INDUSTRY IN FRANCE. J. E. Leger. Preprint S9-21. Prepublication Copy. 19p.

A survey of the French U industry is presented. U deposits in France are described, and the construction of ore-treating plants is discussed. Three different chemical treatments of U ores are used: the ion-exchange technique; solvent extraction; and a two-stage concentration method. The third process, an exclusively French development, has the advantages of delivering directly a pure product and adapting itself well to working deposits far from industrial centers. (M.P.G.)

12360 HEARINGS BEFORE THE SUBCOMMITTEE ON RAW MATERIALS OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SEVENTH CONGRESS, SECOND SESSION ON AEC URANIUM PROCUREMENT PROGRAM, JUNE 18 AND 19, 1962. (United States. Congress. Joint Committee on Atomic Energy). 339p.

Hearings were held before the Subcommittee on Raw Materials of the Joint Committee of Atomic Energy to develop a uranium procurement policy for the post-1966 period. The Government's uranium purchase program terminates Dec. 31, 1966, and unless the growth of uranium-fueled commercial power reactors greatly exceeds present anticipation or defense requirements continue for several years, the U. S. uranium industry faces a sharp reduction in demand from the present rate of >17,000 tons of U_3O_8 to a rate <2,000 tons in 1967. If U. S. production falls to such a level; serious consequences on uranium reserves, the uranium industry, gaseous diffusion plant operations and the cost of nuclear fuel could result. The uranium industry will require a total market of at least 34,160 tons of U_3O_8 over the period 1967 to 1971 inclusive, to sustain it on a minimum basis. (H.G.G.)

12361 IMPROVED ANION-EXCHANGE PROCESS FOR URANIUM RECOVERY. David Anthony Everest and Gordon Henry Elliott Sims (to United Kingdom Atomic Energy Authority). British Patent 906,020. Sept. 19, 1962. Filed Mar. 19, 1958.

A process for separating U from solutions is described which uses an inert polymeric sheet with particles of an anion-exchange resin bonded to its surface. The diameter of the bonded particles should be between 0.3 and 2.0 mm for maximum rate of anionic adsorption of U. The process is particularly useful for treating unclarified solutions or pulp. An example of the preparation and use of such a sheet is given. (D.L.C.)

Separation Processes

Refer also to abstracts 13735 and 13736.

12362 (CEA-2141) FIXATION ET TRANSPORT DE L'URANIUM PAR LES SUBSTANCES HUMIQUES. (Fixation and Transport of Uranium by Humic Substances). Jean Martin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1962. 79p.

Thesis submitted to Université de Paris, France.

A study was made of the part taken by organic substances in ores that contain uranium in a disseminated form, without mineralization, considering the reaction between uranium and humus. Humic acids are extracted from the peat by ammonia. By the fact of their ability to cationic exchange, these form humates with metal cations; monovalent humates, normally soluble in water, can become insoluble after treatment of humic acids with methanol. The polyvalent humates are insoluble in water, especially humates of U (IV) and uranyl U (VI). Action of Li, Na, K, Mg, and Ca uranylcarbonates solutions on the humic acids results in the formation of humates containing uranyl and the other cation. About 100 g of humic acids gave a fixation of no more than 38 g of uranium as uranyl. In contact with uraniferous weakly concentrated solutions, they fixed 4 to 8 g according to pH, with a yield in the extraction greater than 95%. The action of a sodium humate solution on a humate of uranyl gave a solution containing a soluble sodium and uranyl humate. The solution was precipitated at various degrees by the polyvalent cations and insoluble humic substances. In all cases, the fixation of uranium with such prepared humic acids corresponds to a chemisorption of uranyl cations. (auth)

12363 (NAA-SR-8036) COMPARATIVE FUEL CYCLE EVALUATIONS, LOW DECONTAMINATION PYROPROCESSING vs AQUEOUS REPROCESSING. PART I. UO_2 FUEL IN A THERMAL REACTOR. L. J. Colby, Jr., K. L. Mattern, H. Pearlman, E. W. Murbach, and G. E. Brand (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1963. Contract AT-11-1-GEN-8. 40p.

Fuel cycle cost studies on UO_2 fuel indicate an economic advantage for the AIROX (reconstitution of fuel, involving a pyro-oxidation-reduction step), as compared to aqueous reprocessing. The U^{235} inventory and burnup requirements for fuel reprocessed by the AIROX process are higher than for processes that effect complete fission product removal; however, the savings resulting from the simpler on-site closed fuel cycle associated with AIROX more than offset the additional burnup costs. These studies were carried out for a 1000 Mw(e) complex, based on a BWR Reference Reactor. Estimates for both aqueous and AIROX reprocessing charges are presented. (auth)

12364 (NP-12394) DISTRIBUTION OF URANIUM, ZIRCONIUM, NIOBIUM, RUTHENIUM AND CERIUM BETWEEN NITRIC ACID SOLUTIONS AND 10% TLA-5% OCTYL ALCOHOL/SHELL SOL-T. E. López-Menchero, J. Centeno, G. Magni, G. Bardone, and J. Sarda (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Mar 7, 1962. 59p. (ETR-110)

The extraction of traces of Ru, Zr, Nb, Ce, and U at low concentrations (5 mg/l in aqueous solution) from nitric acid solutions using trilauryl amine (TLA) has been experimentally studied. TLA will eventually be used for final purification of plutonium. Room-temperature data on plutonium contaminant distribution between aqueous solutions of varying nitric acid concentrations and a Shellsol-T solution containing 10% TLA and 5% octyl alcohol are presented. Within the temperature and nitric acid concentration ranges tested, the extractability of uranium increased with increased acid concentrations, although acid concentration in the aqueous phase had no effect on the decontamination factors for the main fission products. (H.G.G.)

12365 (ORNL-TM-464) URANIUM–THORIUM SEPARATION BY DI-SEC-BUTYLPHENYLPHOSPHONATE EXTRACTION. A. T. Gresky and R. G. Mansfield (Oak Ridge National Lab., Tenn.). Jan. 31, 1963. Contract [W-7405-eng-26]. 4p.

A preliminary countercurrent scouting test indicates that uranium-233 product (in solutions approximately 150 g U/l, and 1.0 g Th/l, and 1.0 N HNO_3) can be rather effectively separated from its thorium impurities (including Th-228, and probably its daughters) by a solvent extraction process employing 1.0 M di-sec-butylphenylphosphonate (DSBPP)-Solvesso-100 as the uranium extractant. Complete uranium extraction and less than 2% thorium indicated that decontamination factors of greater than 50 are possible in a system employing a scrubbing solution of 1.0 N HNO_3, flow ratios (F/S/O) of 1/0.5/1.6, five stages of extraction, and six stages of scrubbing. (auth)

12366 (RAI-104) THE REMOVAL OF METALLIC IONS BY FOAMING AGENTS AND SUSPENSIONS: LABORATORY AND ENGINEERING STUDIES. Annual Report, July 1, 1961 to June 30, 1962. Eliezer Rubin, Ernest Schonfeld, and Richard Everett, Jr. (Radiation Applications Inc., Long Island City, N. Y.). Oct. 4, 1962. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26]; Subcontract 2024. 121p.

A two-stage process, consisting of a head-end scavenging precipitation to reduce the Ca^{2+} and Mg^{2+} concentrations followed by a countercurrent foam separation column, for removing Sr^{2+} and Cs^{+} from low-activity, high-volume waste solutions was successfully demonstrated in small scale equipment. Radioactive Sr was removed to the extent that its concentration in the effluent from the process was well below the maximum permissible concentration for water. It was found that 90% or more of the Cs can be removed by addition of grundite clay to the head-end precipitator. Important factors involved in this demonstration include ratio of height to diameter of sludge bed (which can be less than 1); precipitant, the most satisfactory being NaOH and Na_2CO_3, each at a concentration of 0.005M in the water; flow rate in the sludge bed, which was increased to 26.5 gal ft^{-2} hr^{-1} to date; surfactant and its concentration in the foam column; effect of pH and the extent of Ca^{2+} and Na^{+} interference in removal of Sr^{2+} and Cs^{+} by foaming; and several foam column parameters, including liquid throughput rate, which was increased to 120 gal ft^{-2} hr^{-1}, gas to liquid flow ratio, and Sr decontamination factor, which varied from ~3 to ~5000 in these experiments. Of the nine most promising surfactants for this process, most experiments were performed with sodium dodecylbenzene sulfonate (as Siponate DS-10 or Trepolate F-95), or Tergitol 7. By measuring the dependence of the foam density on the linear foam rate a

relation between distribution factor, feed throughput rate, and volume reduction, applicable when the decontamination is 100 or more, was established. Other mathematical studies were used to show the variation of the maximum decontamination factor with the ratio of gas flow rate to feed flow rate and bubble diameter (G/F · D). (auth)

12367 (TID-17842) SEPARATION OF GASEOUS MIXTURES OF URANIUM HEXAFLUORIDE AND PLUTONIUM HEXAFLUORIDE BY THERMAL DECOMPOSITION. L. Trevorrow, J. Fischer, and J. Riha (Argonne National Lab., Ill.). Oct. 1962. Contract W-31-109-eng-38. 18p. (UAC-7037)

Experiments were carried out to determine the extent and rate of separation of plutonium hexafluoride from mixtures of uranium hexafluoride and plutonium hexafluoride obtained by thermal decomposition. Gaseous mixtures of uranium hexafluoride, plutonium hexafluoride and helium were circulated for varying lengths of time through nickel vessels at temperatures of 150, 200, and 300°C. The gas phase was analyzed for uranium and plutonium before and after circulation. The amounts of uranium and plutonium in the solid compounds deposited in the vessels were also determined. Passage of the mixtures through the hot vessels resulted in the removal of 99.5 to 99.9% of the plutonium. The solid product remaining in the vessels was plutonium tetrafluoride containing 0.09 to 1.3% uranium. The separation of plutonium hexafluoride from uranium hexafluoride by selective thermal decomposition is applicable to the Direct Fluorination Volatility Process for the recovery of fissile material from reactor fuels. (auth)

12368 (UCRL-Trans-895(L)) CHROMOTOGRAPHIC SEPARATION OF MIXTURES OF ALKALI METALS (ION-EXCHANGE). N. K. Galkina and M. M. Senyavin. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Redkie Shchelochnye Elementy, Akad. Nauk SSSR, Sibirsk. Otd., Sb. Dokl. Soveshch., 1958, 87-96(1960). 17p.

A review concerning development in the area of separation of rare alkaline metal salts by ion-exchange processes including chromatography is presented. Data and discussion are included on separation of K and Rb, Cs and Rb, Li and Na, and Cs and Na. (J.R.D.)

12369 SEPARATION AND RECOVERY OF FISSILE MATERIAL FROM POWER REACTOR FUELS. R. C. Cairns. At. Energy Australia, 6: 13-20(Jan. 1963).

Most processing methods for power reactor fuels fall into three groups: aqueous, pyrometallurgical, and fluoride volatility. In order to illustrate these methods, one example from each group is discussed: aqueous separation of Pu from natural U by the Purex process, pyrometallurgical reprocessing of EBR-2 fuel, and fluidized bed fluoride volatility processes. (D.L.C.)

12370 STUDIES OF THE SOLVENT EXTRACTION OF NIOBIUM-95 IN THE TRIBENZYL AMINE–HYDROCHLORIC ACID SYSTEM. Takashi Omori and Nobuo Suzuki (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 35: 1633-7(Oct. 1962).

The distribution coefficients of Nb^{95} between hydrochloric acid and tribenzylamine were investigated. Discussion is given on the mechanism of amine extraction and the species of Nb in hydrochloric acid. The formation of niobium chlorocomplexes is promoted as the temperature increases, but dehydroxylation may occur simultaneously; therefore, the situation is not simple. (P.C.H.)

12371 SOLVENT EXTRACTION STUDIES OF THIOCYANATE COMPLEX OF THE LANTHANIDES. H. Yoshida (Japan Atomic Energy Research Inst., Tokyo). J. Inorg. Nucl. Chem., 24: 1257-65(Dec. 1962).

The extraction behaviors of thiocyanate complex of the lanthanides were studied for the system $M^{3+}/NH_4SCN/TBP/$ diluent. The distribution ratios were measured as a function of pH, temperature, NH_4SCN, and TBP concentration. The distribution ratios of the lanthanides decrease with increase of hydrogen ion in the aqueous phase because of the extraction of thiocyanate ion into the organic phase. The composition of europium thiocyanate complex extracted into the organic phase is probably $Eu(SCN)_3(TBP)_4$ under the conditions studied. The extraction sequence as a function of the atomic number is compared with the ion exchange sequence for all the lanthanides except Pm. (auth)

12372 THE EXTRACTION OF URANIUM(VI) FROM SULPHURIC ACID SOLUTIONS BY TRI-n-DODECYLAMINE. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. Nucl. Chem., 24: 1267-76 (Dec. 1962).

The partition of uranium (VI) between sulfuric acid solutions and solutions of tri-n-dodecylamine (TDA) in benzene was investigated by varying the sulfuric acid concentration, aqueous uranium concentration, solvent concentration, and temperature; the extraction of sulfuric acid by TDA in benzene was also examined. Infrared spectra were obtained of the organic solutions involved. The mechanism of uranium extraction is discussed in the light of these results. (auth)

12373 SEPARATION OF RARE EARTHS USING CADMIUM HYDROXYCHLORIDE. N. V. Aksel'rud and N. K. Davidenko. Ukr. Khim. Zh., 28: 301-5(1962).

Studies were made of La, Nd, and Pr distribution between cadmium chloride and sodium chloride solutions. The distribution coefficient for [Ln(precep)]/[Ln(soln)] increases with chloride ion concentration. The La–Pr, La–Nd, and Pr–Nd pair separation coefficients calculated for precipitation on cadmium hydroxide indicate a maximum with 3 g-ion/l of chloride in the solution. The separation of La–Nd, La–Pr, and Pr–Nd pairs from 3 M NaCl solution in cadmium hydroxychloride was studied in a 10-step counterflow process. (R.V.J.)

12374 EKSTRAKTISIYA, TEORIYA, PRIMENENIE, APPARATURA. VYPUSK I. (Extraction— Theory, Applications, and Apparatus). A. P. Zefirov and M. M. Senyavin, eds. Moscow, Gosatomizdat, 1962. 216p.

Twelve articles are included on various aspects of extraction mechanisms, treatment of experimental data, and construction of extraction apparatus. Separate abstracts have been prepared for five of the more significant articles. (R.V.J.)

12375 SEPARATION OF Zr AND Hf BY SOLVENT EXTRACTION. G. E. Kaplan, E. D. Moiseev, L. P. Dmitrieva, and S. A. Kostochkina. p.117-24 of "Ekstraktisiya, Teoriya, Primenenie, Apparatura. Vypusk I." Moscow, Gosatomizdat, 1962.

Separation of Zr and Hf by TBP and wet chlorination in nitric acid was studied. An analysis of Zr extraction using trioctylamine in xylene showed that with 20% reagent in 2N xylene the D_{Zr} = 1.4 and in 0.7N xylene D_{Zr} = 5.5. Extraction with 10% reagent and equal phase volumes resulted in D_{Zr} = 0.67 for 0.7N H_2SO_4, 0.42 for 2N H_2SO_4, and 0.31 for 4N H_2SO_4. The coefficient of Zr distribution increases with reagent concentration. With Zr extraction from 2N solutions the D_{Zr} = 0.4 for 10% reagent, 1.4 for 20%, and 14.7 for 30%. Fluorine ions reduce Zr distribution. It was found that phosphoric acid esters and amines effectively contribute to Zr and Hf separation from sulfuric acid solutions. (R.V.J.)

12376 GROUP SEPARATION OF RARE EARTHS BY COUNTER-CURRENT FLOW. G. V. Korpusov, I. V. Eskevich, and E. P. Zhirov. p.125-42 of "Ekstraktisiya, Teoriya, Primenenie, Apparatura. Vypusk I." Moscow, Gosatomizdat, 1962.

Group counter-current separation of rare earths was studied using an initial monazite concentrate, rare earth concentrate separated from cerium and basic lanthanum, and intermediate enriched yttrium subgroups. Distributions were determined for $Ce^{144} \rightarrow Pr^{144}$, Nd^{147}, Pm^{147}, $Eu^{152-154}$, Y^{91}, and Tm^{170}. Contents were determined by x-ray, spectral, and spectrophotometric analyses at ~20°C. (R.V.J.)

12377 URANIUM EXTRACTION WITH TRIOCTYLPHOSPHINE OXIDE. B. N. Laskorin, D. I. Skorovarov, and V. V. Shatalov. p.163-70 of "Ekstraktisiya, Teoriya, Primenenie, Apparatura. Vypusk I." Moscow, Gosatomizdat, 1962.

Solvent extraction of U(VI) by trioctylphosphine oxide (TOPO) synthesized by alkyl magnesium bromide reaction with phosphorus oxychloride ($3C_8H_{17}MgBr + POCl_3 \rightarrow (C_8H_{17})_3PO + 3MgBrCl$) was investigated. Isotherms of U extraction from nitric, hydrochloric, sulfuric, and phosphoric acids by 0.1M TOPO in kerosene were analyzed. The results showed that TOPO is capable of satisfactory uranium extraction from any aqueous acid solution in the presence of small amounts of nitric acid. (R.V.J.)

12378 EXTRACTIVE PROPERTIES OF ALKYL PHOSPHATES. B. N. Laskorin, V. S. Ul'yanov, and R. A. Sviridova. p.171-87 of "Ekstraktisiya, Teoriya, Primenenie, Apparatura. Vypusk I." Moscow, Gosatomizdat, 1962.

Extraction of U from various solutions using mono(2-ethylhexyl) phosphoric acid (M2EHPA), di(2-ethylhexyl) phosphoric acid (D2EHPA), di(2-ethylhexyl) pyrophosphoric acid (D2EHPPA), and their mixtures with TBP, di-isoamyl ether, methylphosphonic acid (DAMPA), and tributylphosphine oxide (TBPO). Uranium distribution isotherms and efficiency graphs are given. (R.V.J.)

12379 ANALYSIS OF THEORETICAL STEPS IN EXTRACTION COLUMN. V. V. Fomin, E. P. Mairova, and R. E. Kartusheva. p.188-201 of "Ekstraktisiya, Teoriya, Primenenie, Apparatura. Vypusk I." Moscow, Gosatomizdat, 1962.

Extraction of uranyl nitrate and nitric acid by TBP was analyzed by determining the number of theoretical steps in an extraction column. Preliminary studies indicated 4 to 5 upper steps for complete U extraction at n = 4.2. The concentration of acid in solution is 2.12 due to reduced aqueous volume. Concentration of U from the sixth step is 5×10^{-4}M, and U is absent at lower stages. Graphs are given for uranium and acid step-by-step distributions. (R.V.J.)

12380 THE REPROCESSING OF IRRADIATED FUELS. Jacques Dressler and Claude Oger (Société Saint-Gobain Nucléaire, [France]). Preprint S3-04. Prepublication Copy. 20p.

The general flowsheet of an aqueous reprocessing plant is described, including the successive stages, treatment of the resulting aqueous solutions, and installations for treating the products coming from the plant. The evolution of reprocessing techniques is shown by a discussion of the operation of plants at Marcoule, La Hague (for the Chinon reactors), and Mol. The dissolution of the U elements, the extraction cycles, the concentration and purification of Pu, and the concentration and storage of fission products in the 3 plants are discussed. The construction of plant areas for Pu purification and high gamma activity and the problems involved in effluent treatment are also considered. (M.P.G.)

12381 IMPROVEMENTS IN OR RELATING TO THE REMOVAL OF SHEATHS FROM NUCLEAR REACTOR FUEL ELEMENTS. Dennis Moorhouse and Roy William Silvester (to United Kingdom Atomic Energy Authority). British Patent 915,506. Jan. 16, 1963. Filed July 9, 1959.

An apparatus was provided for removing the protective sheath from nuclear fuel elements after irradiation. The apparatus could accommodate fuel elements that differ in diameter and length and fuel elements having variations in diameter along their lengths. (C.E.S.)

12382 PROCESS FOR THE RECOVERY AND/OR CONCENTRATION OF URANIUM AND MELT CONTAINING URANIUM. (to Dow Chemical Co.). British Patent 917,402. Feb. 6, 1963. Priority date Aug. 26, 1958, United States.

A pyrometallurgical process is outlined for processing alloys containing U and Al, such as spent reactor fuel. The process comprises forming a melt of U, Al, and Mg, wherein all of the U is present as a precipitate of UAl_2 and/or UAl_3. The precipitate is separated from the melt at a temperature less than 100°C higher than the solidification temperature of the melt, and may be further treated with Mg until part or all of the Al is removed from the precipitate. Residual Mg may be removed by evaporation in vacuo. (D.L.C.)

12383 MATERIAL EXCHANGE COLUMNS. (to Sulzer Freres, Societe Anonyme). British Patent 918,303. Feb. 13, 1963. Priority date July 22, 1959, Switzerland.

A material exchange column, having ducts in which liquid and vapor are conducted in countercurrent, is designed for the separation of a gaseous mixture or an isotopic mixture. Each duct communicates through a passage with a common withdrawal chamber, and each passage includes a non-return valve arranged to open and close in response to the difference in pressure between the withdrawal chamber and the duct. Means is provided for adjusting the pressure in the withdrawal chamber to effect simultaneous opening or closing of the valves. Parts of the column are described in more detail by British Patents 918,304 and 918,305. (D.L.C.)

12384 RECTIFYING COLUMNS. (to Sulzer Freres, Societe Anonyme). British Patent 918,304. Feb. 13, 1963. Priority date July 22, 1959, Switzerland.

A column is designed for the separation of a gaseous or isotopic mixture by means of countercurrent liquid-gas exchange. The column comprises a group of ducts in which the exchange is conducted, and a common reflux condenser for producing the reflux liquid for all the ducts. The reflux condenser comprises an annular chamber surrounding the ducts and open to the vapor from the upper ends of the ducts. Other parts of the column are described by British Patents 918,303 and 918,305. (D.L.C.)

12385 MATERIAL EXCHANGE COLUMNS. (to Sulzer Freres, Societe Anonyme). British Patent 918,305. Feb. 13, 1963. Priority date July 22, 1959, Switzerland.

A material exchange column is designed for separation of a gaseous or isotopic mixture by means of countercurrent liquid-vapor exchange. The column includes a number of parallel ducts in which the exchange is conducted, a common distribution tank for the mixture adjacent the lower end of the column, and a tube for each duct extending upwardly from the tank and opening to the interior of the duct. Other parts of the column are described by British Patents 918,303 and 918,304. (D.L.C.)

12386 SEPARATION OF EUROPIUM FROM OTHER LANTHANIDE RARE EARTHS BY SOLVENT EXTRACTION. Donald F. Peppard, Earl Philip Horwitz, and George W. Mason (to U. S. Atomic Energy Commission). U. S. Patent 3,077,378. Feb. 12, 1963.

This patent deals with a process of separating europium from other lanthanides present in aqueous hydrochloric or sulfuric acid solutions. The europium is selectively reduced to the divalent state with a divalent chromium salt formed in situ from chromium(III) salt plus zinc amalgam. The other trivalent lanthanides are then extracted away from the divalent europium with a nitrogen-flushed phosphoric acid ester or a phosphonic acid ester. (AEC)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstract 13867.

12387 (AD-278078) FEASIBILITY STUDY AND INVESTIGATION OF THERMOELECTRIC POWER GENERATION AND COOLING FOR FLIGHT VEHICLES. Final Phase I Summary Report (Report No. 11) March 1, 1962 thru April 1, 1962. H. L. Hall, L. B. Buss, J. I. Allyn, P. L. Catron, and W. D. Himebaugh (Douglas Aircraft Co., Inc., Long Beach, Calif.). Contract NOw 61-0404-1. 137p.

The feasibility of thermoelectric cooling systems for flight vehicles was studied. Applications considered were occupied compartments in the aircraft and avionic equipment cooling. Thermoelectric cooling systems compare favorably with existing cooling systems for subsonic aircraft electronic equipment, having a cooling load up to 1.5 kw and an allowable temperature level equivalent to MIL-E-5400, class I. Thermoelectric cooling loads greater than 1.5 kw are feasible for subsonic aircraft electronic equipment having an allowable temperature level higher than specified in MIL-E-5400, class I (such as class II equipment). An improvement of 43% in thermoelectric material properties doubles the feasible range of cooling loads for class I equipment to 3 kw. Special classes of equipment requiring temperature levels lower than class I also become feasible for cooling loads under 3 kw; with the maximum feasible cooling load depending upon the maximum allowable temperature of the equipment. Cooling of cockpits or of electronic equipment for supersonic airplanes is not feasible with current thermoelectric materials. (auth)

12388 (AD-278285) THE DYNAMIC RESPONSE OF SHALLOW-BURIED ARCHES SUBJECTED TO BLAST LOADING (thesis). Caryll Robbins Whipple (Illinois. Univ., Urbana). June 1961. Contract AF29(601)-2591. 223p.

A study was made of the effectiveness of the surrounding soil in restraining the lateral movement of shallow-buried arches subjected to blast overpressures from nuclear explosions. The theory is developed for parabolic arches with circular or barrel arches included as a special case. It can be applied equally well to arches oriented with their longitudinal axes perpendicular to or parallel to the direction of travel of the blast wave. The arch is considered to be buried near the surface of a semi-infinite soil mass. The depth of cover over the crown is limited to one-half of the arch span. The two-hinged rather than the fixed arch is selected as representing more closely the shallow-buried arch structures used in full-scale nuclear tests to date. While these structures were not actually pinned at the arch abutments, their behavior under blast loading appears to resemble more closely the pinned than the fixed case. The principal variables studied in the numerical examples include depth of cover, over-pressure loading, arch material, and arch span. (auth)

12389 (AECL-1658) REMOTE HANDLING FACILITIES AT CHALK RIVER. S. Ananthakrishnan, comp. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1962. 50p.

The Chalk River hot cell facilities for inspection of irradiated fuel materials are described. Included are descriptions of the cells, viewing facilities, lighting, waste disposal, specimen storage, ventilation, and operating philosophy. (J.R.D.)

12390 (ANL-SL-SL-2342) MASS TRANSFER FROM A VERTICAL PLATE OF NAPHTHALENE TO A SURROUNDING AIR-FLUIDIZED BED. John T. Holmes and W. Jay Pettit (Argonne National Lab., Ill.). Nov. 1962. Contract W-31-109-eng-38. 23p. (UAC-7089)

A computer program was devised for the IBM 704, which can be used to correlate the mass transfer rate data from submerged surfaces to a surrounding fluidized bed. The general form of the equation is $Nu' = a\,Re^{n}\,Sc^{m}\,(1-E)^{c}\,(G/G_m)^{f}$. Data for the mass transfer from naphthalene plates in an air-fluidized bed were best correlated by the following least-square fit of 40 experiments. $k'1/D = 18.9\,(G1/\mu)^{0.56}\,(G/G_m)^{0.20}$ or $k'1/D = 13.8\,(G1/\mu)^{0.64}\,(G/G_m)^{0.38}\,(1-E)^{0.64}$. Improved techniques for measuring the mass transfer coefficients and suggestions for future mass and heat transfer studies are also outlined. (auth)

12391 (BNL-764) AN AUTOMATIC LIQUID-NITROGEN TRANSFER SYSTEM. George J. Hummer (Brookhaven National Lab., Upton, N. Y.). Jan. 1962. Contract [AT(30-2)-Gen-16]. 7p. (BNL-T-285)

Experimental facilities now in use at many research reactors consume large quantities of liquid nitrogen. The manual distribution of the liquid nitrogen entails the use of many man-hours. This note describes an automatic liquid-nitrogen transfer system, capable of delivering in the order of 30 liters of liquid nitrogen per minute, now in use at the Brookhaven Graphite Research Reactor. (auth)

12392 (DASA-1259) INVESTIGATION OF RESISTANCE AND BEHAVIOR OF REINFORCED CONCRETE MEMBERS SUBJECTED TO DYNAMIC LOADING. PART III. Civil Engineering Studies, Structural Research Series No. 243. A. Feldman, W. A. Keenan, and C. P. Siess (Illinois. Univ., Urbana. Engineering Experiment Station). Feb. 1, 1962. Contract DA-49-129-eng-344. 367p. (AD-278219).

An investigation was made to obtain, by means of tests, information which will contribute to a better understanding and more accurate prediction of the strength and behavior of reinforced concrete structures subjected to dynamic loading. The immediate objective was the determination of the resistance and behavior of simple-span reinforced concrete beams subjected to impulsive loading. To accomplish this, tests of beams and of reinforcing bar coupons were made and the resulting data analyzed. The practicability of an existing method of computing the resistance of dynamically loaded reinforced concrete beams was also checked. To this end, comparisons were made between the test results and the prediction of the method of analysis. (auth)

12393 (HW-64154) 100-N DECONTAMINATION FACILITY DESIGN GUIDE. W. D. Bainard (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 8, 1960. Contract AT(45-1)-1350. 13p.

The concepts and data necessary for designing a decontamination facility that will be capable of applying the process that is ultimately chosen to decontaminate the NPR primary loop at the 100-N site are discussed. Schematic piping diagrams of decontamination processes are included. (H.G.G.)

12394 (TID-17830) FORCING CIRCUITS FOR ELECTROMAGNETS. J. F. Mech and S. W. Zimmerman

(Argonne National Lab., Ill.). Aug. 31, 1962. Contract [W-31-109-eng-38]. 12p.

The establishment or decay of an electromagnetic field in a short period of time as compared to the time constant of the circuit is discussed. The forcing characteristics associated with the establishment or decay of flux are analyzed. The magnet current can be reduced to 5% of normal flux in ~5 msec. During this period, the voltage across the magnet was ~4.5 kv as the crest of a voltage pulse. The use of a vacuum tube or other nonlinear element has the effect of a more definite cutoff of the circuit since the logarithmic curve does not approach zero quickly. A nonlinear conduction device may be selected that will provide a definite open circuit at extinguishing potential. (H.G.G.)

12395 RADIATION-RESISTANT GREASES—A STUDY OF THICKENERS AND ANTIRADS. W. Crawford and D. B. Cox. J. Inst. Petrol., 47: 267-83(Aug. 1961).

The suitability of various non-soap thickeners in the compounding of greases stable to ionizing radiation is discussed on the basis of static irradiation data. Thickeners assessed include modified clays and silicas, a dye pigment, an aryl urea, and magnesium n-octadecyl terephthalamate. Side effects due to fluid polymerization are defined by the use of lubricating fluids of differing radiation stabilities, each thickener being used in conjunction with an alkyl phenyl silicone, a refined petroleum bright stock, and/or a synthetic aromatic, respectively. Additives are described which act as "energy absorbers" or "free radical scavengers." These materials, "antirads," are shown to boost the radiation stability of a modified clay/silicone fluid grease by up to 1000 megarads. Facilities for the simultaneous irradiation and bearing rig testing of greases are described. It is shown that the interaction of grease composition, method of test irradiation, and method of damage evaluation are complex, and that development of radiation-resistant greases for different environments requires understanding of this interaction. (auth)

12396 ENERGY CONVERSION TECHNIQUES. K. G. Hernqvist (RCA Labs., Princeton, N. J.). Proc. I.R.E. (Inst. Radio Engrs.), 50: 1285-8(May 1962).

The conception and evolution of the basic principles of thermionic energy conversion, the newest of the heat-to-electricity conversion methods, are described. The application of thermionic energy converters to its ideal heat source, the fission reactor, is discussed. It is believed that the state of the art is far enough advanced to make such a thermionic-reactor system practical within the next decade. (auth)

12397 MECHANIC PUMPS FOR LIQUID SODIUM DEVELOPMENT FOR THE 10 MW TEST CIRCUIT OF THE "RAPSODIE" REACTOR. M. R. Blum. Preprint. Prepublication Copy. 4p.

A centrifugal pump for the Na coolant of the rapid neutron reactor, Rapsodie, is described. The advantages of a mechanical pump over an electromagnetic pump are listed, and the special problems involved in the design of the pump are discussed. Two pumps, one with a pumping capacity of 350 m^3/hr and the other with a pumping capacity of 480 m^3/hr, are now working on the Rapsodie testing circuit and meet all the requirements of flow, pressure, and security at all required speeds. (M.P.G.)

12398 PERFORMANCE OF PHOTOVOLTAIC CELLS AT HIGH RADIATION LEVELS. P. Schoffer and C. Pfeiffer (Univ. of Wisconsin, Madison). Preprint Paper No. 62-WA-348. New York, The American Society of Mechanical Engineers, 1962. 8p. $1.00.

Paper from Winter Annual Meeting, New York, Nov. 1962.

The performance of p-n gridded, water-cooled silicon photovoltaic cells was measured at radiation levels of up to 250 Langley per minute. Outputs exceeded ¼ watt per square centimeter. An analysis of cell operation at high fluxes permits computation of the performance over a wide range of radiation intensities from a single high-radiation voltage-current curve. An array of eight p-n cells and an optical system used with the array is described. Characteristics of n-p cells were measured, and their peculiar voltage-current curves are noted. Methods of improving cell performance at high fluxes are discussed. (auth)

12399 RELIABILITY IN HELIUM LIQUEFACTION. J. W. T. Dabbs (Oak Ridge National Lab., Tenn.). p.105-7 of "Proceedings of Commissions Meetings, International Institute of Refrigeration, London, Sept. 1961." Paris, Institut International du Froid, [1962].

A system consisting of two He liquefiers, one of which is used as the on-line machine and the other as a standby machine, is described. The addition of the standby liquefier reduces system downtime caused by malfunctioning in the on-line liquefier. The capability of the system is estimated as 1000 liter/month. (T.F.H.)

12400 AN APPARATUS FOR AUTOMATIC CONVEYING OF RADIO-ACTIVE PREPARATIONS DURING MEASURING. Ladislav Vosahlik (to Tesla, Norodni Podnik). British Patent 905,220. Sept. 5, 1962. Filed Dec. 23, 1959.

A simple mechanical apparatus is designed for picking up a radioactive preparation from a first container, putting it under a feeler for radioactivity measurement, and carrying it into a second container. The apparatus comprises a rotating disc provided with cam elements for effecting the transfer. (D.L.C.)

12401 ELECTRO-MAGNETIC GRIPPING DEVICE. Pierre Vidal. British Patent 907,634. Oct. 10, 1962. Priority date Oct. 27, 1959, France.

An electromagnetic device is designed for remotely manipulating small objects which have a magnetic material, e.g., Co^{60} wafers with ferromagnetic sheaths. The device is shaped as a pistol with the trigger controlling the longitudinal displacement of a rod terminated at the other end by a hinged lever carrying an electromagnet. The device makes it possible to bring the handled object from a horizontal to a vertical position or to any intermediate position. (D.L.C.)

12402 IMPROVEMENTS IN OR RELATING TO A SYSTEM FOR VIEWING AN OBJECT THROUGH A LAYER OF LIQUID. (to Compagnie de Saint Gobain). British Patent 914,807. Jan. 2, 1963. Priority date Mar. 8, 1958, France.

An apparatus is designed for viewing in water objects or operations which give rise to radiations, e.g., unsheathing of uranium rods. The apparatus comprises a tube closed at the upper end by a lens and at the other end by a transparent element, and filled with a transparent liquid to protect the observer and the lens. The lens is a concavo-convex lens with both faces parallel and is mounted with the concave face in contact with the liquid in the tube to give an enlarged image of the object. The tube is suspended and moved by means of a movable carriage. (D.L.C.)

12403 MANIPULATOR FOR THE REMOTE HANDLING OF ARTICLES, PARTICULARLY FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Electricite de France,—Service National). British Patent 915,633. Jan. 16, 1963. Priority date July 28, 1959, France.

The handling apparatus is of use, in handling an article, even in a finely distributed condition, inside a chamber that is accessible only with difficulty. (C.E.S.)

12404 IMPROVEMENTS IN AND RELATING TO COMPOSITE RODS COMPRISING TWO OR MORE ROD-LIKE UNITS. Hermann Charles Pontet and Anthony Aloysius Pontet. British Patent 915,717. Jan. 16, 1963. Filed Aug. 10, 1959.

Rod units were adapted to be detachably secured to similar rod units to form a composite rod of any desired length. (C.E.S.)

12405 IMPROVEMENTS IN OR RELATING TO AN IONIZATION GETTER PUMP. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 915,748. Jan. 16, 1963. Priority date June 6, 1958, Germany.

An ionization getter pump was described in which the pumping action arose out of a constant formation of fresh sorption layers by cold cathodic atomization of getter material and simultaneous ionization and stimulation of the gas molecules in the presence of a magnetic field lying approximately parallel to the electric field. Two different groups of surfaces were employed, the first to atomize the getter material and the second to receive the sorption layers thus formed. The second group of surfaces effectively bounded the discharge space, at least on the sides perpendicular to the electrical and magnetic field lines effecting the discharge. (C.E.S.)

12406 IMPROVEMENTS IN GLANDS FOR SHAFTS ROTATABLE AT HIGH PERIPHERAL SPEEDS. Robert Le Rossignol (to General Electric Co. Ltd.). British Patent 916,150. Jan. 23, 1963. Filed June 23, 1947.

A gland giving efficient sealing against the flow of gases and in which there are no rubbing contacts was the object of this invention. The gland was for a shaft member rotatable at a high peripheral speed comprising two like surfaces of revolution. One of the surfaces was provided with helical or spiral grooves extending from a central region to connect with the two sides of the gland, which required substantial sealing. The central region was sealed from the outside end of the glands except through the grooves and the clearance between the surfaces. The senses of the helices or spirals and the arrangements were such that when the shaft member was rotated in the appropriate direction at a suitable speed a vacuum was produced in the central region. (C.E.S.)

12407 TRAVELLING CRANE FOR PRECISE OPERATION. Vsevolod Dachkevitch (to Commissariat a l'Energie Atomique). British Patent 917,137. Jan. 30, 1963. Priority date May 6, 1958, France.

A traveling crane was described for precise operation. Precision was obtained without intervention by the operator. The apparatus could be employed automatically or semi-automatically. The operator could control operation from a protective shelter which prevented contact with radioactive or other dangerous substances. (C.E.S.)

12408 MASTER AND SLAVE MANIPULATORS. Paul Oppenheimer and Michael Martin (to Joseph Lucas Industries Ltd.). British Patent 917,545. Feb. 6, 1963. Filed Mar. 15, 1960.

A master and slave manipulator was provided whereby the forces applied by the operator can be magnified while giving the operator a "feel" in order that he may have sensitive and precise control. (C.E.S.)

12409 IMPROVEMENTS IN OR RELATING TO RADIATION SOURCES. William Henry Holland and John Grant (to United Kingdom Atomic Energy Authority). British Patent 917,878. Feb. 6, 1963. Filed May 16, 1960.

A radiation source for irradiating packages is designed in which the difficulties of loading and unloading of the source are minimized. The source comprises a plurality of closed containers for enclosing radioactive material and arranged in a spaced parallel arrangement within a tiltable frame member. A latch member is provided for holding the frame in a vertical position during irradiation or for tilting the frame during container loading and unloading. (D.L.C.)

12410 FLUID SAMPLING DEVICE. Walter W. Kenyon (to Millipore Filter Corp.). British Patent 918,161. Feb. 13, 1963. Filed Aug. 5, 1961.

A sampling device for collecting and simultaneously filtering the sample to collect the solid contaminants preliminary to analysis was described. The invention was particularly suited for the sampling of liquids in pressurized systems. (C.E.S.)

12411 IMPROVEMENTS IN UNIVERSAL MOUNTINGS FOR MANIPULATING EXTENDING THROUGH RADIATION SHIELDING WALLS. Kenneth McFarlane (to Associated Lead Mfg. Ltd.). British Patent 918,183. Feb. 13, 1963. Filed Dec. 7, 1960.

A universal mounting, which includes no gaps for radiation passage, consisted of an inner sphere rotatable about a first axis with respect to a surrounding shell and an outer shell fitted in the shielding wall rotatable about a second axis at right angles to the first. The outer shell was formed with slots permitting universal rotation about the point of intersection of the two axes. (C.E.S.)

12412 IMPROVEMENTS RELATING TO PRESSURE VESSELS. Norman George Worley and Michael Rooney (to Babcock and Wilcox Ltd.). British Patent 918,230. Feb. 13, 1963. Filed June 26, 1958.

A pressure vessel was adopted to operate at elevated temperature and supported from below by a skirt rigidly united with the vessel. A relatively low temperature gradient was maintained along the length of the skirt with the result that stresses were limited to relatively low values. (C.E.S.)

12413 IMPROVEMENTS IN OR RELATING TO RELEASABLE COUPLING MEANS. James Harry Steen (to General Electric Co. Ltd.). British Patent 918,677. Feb. 13, 1963. Filed Feb. 27, 1959.

A releasable coupling means was described for coupling coaxial telescoping members. (C.E.S.)

12414 IMPROVEMENTS IN OR RELATING TO UNIVERSAL COUPLING MEANS. James Harry Steen (to General Electric Co. Ltd.). British Patent 918,678. Feb. 13, 1963. Filed Feb. 27, 1959.

Fuel feeding gear for a nuclear reactor was described, comprising a two-part universal coupling. The releasable coupling member had a plurality of pivoted members arranged radially around a common axis and a plunger arranged to be moved along the common axis to move the pivoted members to or from engagement position. (C.E.S.)

12415 IMPROVEMENTS RELATING TO TELEVISION INSPECTION APPARATUS. John Owen Tattersall and George Camac (to AEI-John Thompson Nuclear Energy Co. Ltd.). British Patent 918,697. Feb. 13, 1963. Filed Dec. 17, 1959.

A television inspection apparatus for remote locations was described with application in apparatus for removing broken particles of fuel elements from the fuel channels of nuclear reactors. The invention comprised a television

camera and supply cable together with mechanical handling apparatus for gripping broken particles. (C.E.S.)

12416 COMPRESSION SEAL AND SEALING MATERIAL THEREFOR. T. G. Branin (to U. S. Atomic Energy Commission). U. S. Patent 3,036,674. May 29, 1962.

This patent relates to compression seal and more particularly to a sealing material therefor. The sealing surface is a coating consisting of alternate layers of gold and of a non-gold metal having similar plastic flow properties under pressure as gold. The coating is substantially free from oxidation effects when exposed to ambient atmosphere and does not become brittle when worked, as in a valve. (AEC)

12417 BAKABLE ULTRA-HIGH VACUUM VALVE. J. T. Mark and I. H. Gantz (to U. S. Atomic Energy Commission). U. S. Patent 3,043,323. July 10, 1962.

This patent relates to a valve useful in applications involving successively closing and opening a communication between a chamber evacuated to an ultra-high vacuum condition of the order of 10^{-10} millimeters of mercury and another chamber or the ambient. The valve is capable of withstanding extended baking at 450°C and repeated opening and closing without replacement of the valve seat (approximately 200 cycle limit). The seal is formed by mutual interdiffusion weld, coerced by a pneumatic actuator. (AEC)

12418 ROCKET PORT CLOSURE. James Thomas Mattingly (to U. S. Atomic Energy Commission). U. S. Patent 3,077,113. Feb. 12, 1963.

This invention provides a simple pressure-actuated closure whereby windowless observation ports are opened to the atmosphere at preselected altitudes. The closure comprises a disk which seals a windowless observation port in rocket hull. An evacuated instrument compartment is affixed to the rocket hull adjacent the inner surface of the disk, while the outer disk surface is exposed to the atmosphere through which the rocket is traveling. The pressure differential between the evacuated instrument compartment and the relatively high pressure external atmosphere forces the disk against the edge of the observation port, thereby effecting a tight seal. The instrument compartment is evacuated to a pressure equal to the atmospheric pressure existing at the altitude at which it is desired that the closure should open. When the rocket reaches this preselected altitude, the inwardly directed atmospheric force on the disk is just equaled by the residual air pressure force within the instrument compartment. Consequently, the closure disk falls away and uncovers the open observation port. The separation of the disk from the rocket hull actuates a switch which energizes the mechanism of a detecting instrument disposed within the instrument compartment. (AEC)

12419 SERVICING EQUIPMENT FOR NUCLEAR REACTORS. Robert Tait, Robert Hugh Hall, and Charles John MacFarlane (to United Kingdom Atomic Energy Authority). U. S. Patent 3,077,361. Feb. 12, 1963. Priority date July 19, 1957, Great Britain.

A device with remote viewing means is designed for servicing operations inside reactors. The device comprises an elongated television camera within a casing, a tool holder rotatable in front of the camera, and means for rotating the tool holder and for operating tools fitted in the holder. (D.L.C.)

12420 METHOD OF LUBRICATING MACHINERY EXPOSED TO HIGH INTENSITY IONIZING RADIATION. Morton Z. Fainman (to Standard Oil Co.). U. S. Patent 3,077,452. Feb. 12, 1963. Filed July 28, 1958.

A lubricant oil is described which has radiation resistance and high-temperature stability. The oil employs a vehicle which comprises 25 to 75% of a hydrogenated polybutene oil and the rest of another hydrocarbon oil. Preferably, the oil also contains an oxidation inhibitor such as dilauryl selenide or phenyl-alpha-naphthylamine. (D.L.C.)

12421 VACUUM TRAP AND VALVE COMBINATION. Norman Milleron and Leonard Levenson (to U. S. Atomic Energy Commission). U. S. Patent 3,077,712. Feb. 19, 1963.

This patent relates to a vacuum trap and valve combination suitable for use in large ultra-high vacuum systems. The vacuum trap is a chamber having an inlet and outlet opening which may be made to communicate with a chamber to be evacuated and a diffusion pump, respectively. A valve is designed to hermetically seal with inlet opening and, when opened, block the "line-of-sight" between the inlet and outlet openings, while allowing a large flow path between the opened valve and the side walls of the trap. The interior of the trap and the side of the valve facing the inlet opening are covered with an impurity absorbent, such as Zeolite or activated aluminum. Besides the advantage of combining two components of a vacuum system into one, the present invention removes the need for a baffle between the pump and the chamber to be evacuated. In one use of a specific embodiment of this invention, the transmission probability was .45 and the partial pressure of the pump fluid vapor in the vacuum chamber was at least 100 times lower than its vapor pressure. (AEC)

12422 COAXIAL TUBE COUPLING. Hubert R. Niemoth (to U. S. Atomic Energy Commission). U. S. Patent 3,079,179. Feb. 26, 1963.

This patent shows a device for quickly coupling coaxial tubes in metal-to-metal fashion, so as to be suitable for use in a nuclear reactor. A threaded collar urges a tapered metal extension on the outer coaxial tube into a tapered seat in the device and simultaneously exerts pressure through a coaxial helical spring so that a similar extension on the inner tube seats in a similar seat near the other end. (AEC)

12423 COUPLING. B. C. Hawke (to U. S. Atomic Energy Commission). U. S. Patent 3,079,323. Feb. 26, 1963.

This patent relates to a releasable coupling connecting a control rod to a control rod drive. This remotely operable coupling mechanism can connect two elements which are laterally and angularly misaligned, and provides a means for sensing the locked condition of the elements. The coupling utilizes a spherical bayonet joint which is locked against rotation by a ball detent lock. (AEC)

12424 COLD TRAP. Norman Milleron (to U. S. Atomic Energy Commission). U. S. Patent 3,081,068. Mar. 12, 1963.

An improved linear-flow cold trap is designed for high-vacuum applications such as mitigating back migration of diffusion pump oil molecules. A central pot of liquid nitrogen is nested within and supported by a surrounding, vertical, helical coil of metal sheet, all enveloped by a larger, upright, cylindrical, vacuum vessel. The vertical interstices between successive turns of the coil afford lineal, axial, high-vacuum passages between open mouths at top and bottom of said vessel, while the coil, being cold by virtue of thermal contact of its innermost turn with the nitrogen pot, affords expansive proximate condensation surfaces. (AEC)

Heat Transfer and Fluid Flow

Refer also to abstract 13684.

12425 (TID-17831) RADIAL HEAT CONDUCTION IN HOLLOW CIRCULAR CYLINDERS WITH TIME-

DEPENDENT BOUNDARY CONDITIONS AND HEAT SOURCES. Nurettin Y. Olcer and David Miller (Argonne National Lab., Ill.). Oct. 1962. Contract [W-31-109-eng-38]. 21p. (UAC-7018)

The method of finite Hankel Transform is used to obtain expressions for the radial temperature distribution in a hollow circular cylinder with general time-dependent boundary conditions and internal heat generation. The initial temperature distribution is an arbitrary function of the radial space variable, and the volume heat generation rate is an arbitrary function of time and radial space variable. The boundary conditions state that at the inner and outer surfaces of the cylinder a linear combination of the temperature and its gradient is equal to an arbitrary function of time. From these, all the boundary conditions of engineering significance are easily obtained as special cases. (auth)

12426 (WAPD-TM-323) ANALYSIS OF CHECK VALVE DISC MOTION DURING A FLOW TRANSIENT. G. M. Fuls (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1962. Contract NObs 78844. 41p.

An analysis of the dynamics of a check valve disc under the influence of a flow transient is presented. The impact velocities of the disc and the pressure surge resulting from extinguishing a fluid velocity are predicted. This analysis develops the equations of motion of a simple swing disc check valve from Newton's Second Law. Modifications of the analysis necessary for application to other types of valves are described. The developed equations are programmed for the Philco-2000 digital computer in FORTRAN as the SLAM Code. The Code input consists of the characteristics of the valve and the flow transient. The output of the code includes the dynamics of the valve disc as a function of time and the pressure surge induced by valve closure. (H.G.G.)

12427 (WAPD-TM-342) A SMALL PERTURBATION APPROACH TO THE STUDY OF PARALLEL CHANNEL BOILING FLOW OSCILLATIONS. J. E. Meyer and E. A. Reinhard (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1963. Contract AT(11-1)-Gen-14. 44p.

A method is discussed for treating oscillations in flow through a heated boiling channel which connects two plenum regions of constant pressure difference. The method is based on linearizing equations representing conservation laws in the fluid. The resulting linearized equations are used to determine system response to small perturbations by using standard matrix techniques to form the characteristic equation of the system and to determine its characteristic roots or eigenvalues. The method can be used for spatially varying heat flux, and for flow with and without slip. (auth)

12428 (GA-tr-2704) STABILIZATION OF FLOW DISTRIBUTION IN FORCED-FLOW HEATING SURFACES. P. Profos. Translated for General Atomic Div., General Dynamics Corp., San Diego, Calif., from Energie 11: 241-7(June 1959). 27p.

The unbalances in the flow distribution in heated forced-flow piping systems may follow an aperiodic or a periodic course and thus make satisfactory cooling of the heating element doubtful, resulting in pipe damage caused from static or dynamic overloading. The characteristic stability curve can be determined with sufficient accuracy for practical purposes and the flow distribution ascertained for a particular system from the characteristic stability curve. The characteristic stability number of a heating surface system can be increased by superimposing the pressure drop, which can be accomplished by introducing throttling valves at the intake of the pipes or by choosing greater flow velocities and a greater pressure drop in the initial portion of the heating surface. (H.G.G.)

12429 NUCLEATE BOILING. THE REGION OF ISOLATED BUBBLES AND THE SIMILARITY WITH NATURAL CONVECTION. Novak Zuber (General Electric Co., Schenectady, N. Y.). Intern. J. Heat Mass Transfer, 6: 53-78 (Jan. 1963). (In English)

Experimental data indicate that nucleate boiling consists of two regions, (a) the region of isolated bubbles and (b) the region of interference. The vapor removal pattern, the flow pattern, and the mechanisms of heat transfer in the two regions are discussed and analyzed. A criterion for the change from one region to another is presented. In the regime of isolated bubbles, bubbles do not interfere with each other and at any particular point vapor is produced intermittently. Jakob's description of the natural flow circulation in nucleate pool boiling from a horizontal surface is similar to Malkus' and Townsend's description of the flow regime in turbulent natural convection from a horizontal surface. In both cases the heat transfer is caused by the "up-draught" induced circulation. It is shown that the same equations which predict the heat-transfer coefficient and the average turbulent velocity fluctuation in natural turbulent convection from a horizontal surface can be used in the regime of isolated bubbles if the vapor void coefficient, i.e., the vapor hold-up is taken into account in evaluating the mean density of the fluid. Equations relating the vapor void coefficient to the heat-transfer coefficient or to the bubble population density and liquid superheat temperature are presented. It is shown that an upper limit exists for the heat-transfer mechanism induced by the "up-draught" circulation. Equations predicting the limiting value of the heat-transfer coefficient and of the heat flux density in the regime of isolated bubbles are presented also. All these results, predicted by the analysis, are shown to be in qualitative and quantitative agreement with experimental data presently available. In the region of interference, bubbles interfere with each other to form continuous vapor columns and patches. Vapor is continuously produced by vaporization of a pulsating micro-layer (proposed and described by Moore and Mesler) at the base of a vapor column or of a vapor patch. In this regime the dominant heat-transfer mechanism is, most probably, the latent heat transport process (formulated by Gaertner) and the latent heat transport associated with the large bursts of vapor caused by collapsing vapor patches. The results of the analysis indicate that a particular regime of nucleate pool boiling (a two-phase problem) can be analyzed as a turbulent natural convection problem (a single-phase problem). Applications of similar considerations to other aspects of the two-phase flow appear therefore promising. The important effect of the two-phase flow patterns on the mechanism of heat transfer and on the coefficient of heat transfer for a two-phase mixture is demonstrated again, emphasized and discussed. (auth)

12430 HEAT TRANSFER BIBLIOGRAPHY. E. R. G. Eckert, E. M. Sparrow, W. E. Ibele, and R. J. Goldstein (Univ. of Minnesota, Minneapolis). Intern. J. Heat Mass Transfer, 6: 91-112(Jan. 1963). (In English)

An international bibliography of recent papers in heat and mass transfer is listed by title, author, and source. (C.E.S.)

12431 STEADY FLOW OF A CONDUCTING NON-NEWTONIAN FLUID IN AN ANNULUS UNDER A RADIAL MAGNETIC FIELD AND WITH SUCTION AND INJECTION.

J. N. Kapur and R. K. Rathy (Indian Inst. of Tech., Kanpur). Istanbul Univ. Fan Fek. Mecmuasi, Ser. A, 26: 61-8(1961).

The flow of a conducting non-Newtonian fluid in an annulus under a radial magnetic field and constant pressure gradient is considered. The solution is obtained in powers of the cross-viscosity Reynolds number which is assumed to be small. The discussion includes cases when the walls are moving or stationary. The flow between parallel plates is obtained as a limiting case. (auth)

12432 DETERMINATION OF LOCAL AND AVERAGE HEAT-TRANSFER COEFFICIENTS FOR FUEL ELEMENTS OF THE RESEARCH REACTOR IRT. V. I. Gomelauri and G. V. Ratiani. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 25-40(1962). (In Russian)

A number of laws defining the processes of heat exchange in casettes of a nuclear reactor of the IRT type was established on the basis of the analysis of the published data and as a result of experimental investigations. (auth)

12433 THE INFLUENCE OF AXIAL HEAT-FLUX DISTRIBUTION ON THE DEPARTURE FROM NUCLEATE BOILING IN A WATER-COOLED TUBE. H. S. Swenson, J. R. Carver, and C. R. Kakarala (Babcock and Wilcox Co., Alliance, Ohio). Preprint Paper No. 62-WA-297. New York, The American Society of Mechanical Engineers, 1962. 13p. $1.00.

Paper from Winter Annual Meeting, New York, Nov. 1962.

The effect of nonuniform axial heat-flux distributions, present in the core channels of a heterogeneous water-cooled nuclear power reactor, on the phenomenon of "departure of nucleate boiling" (DNB), and therefore, on the heat-transfer performance of the reactor, was experimentally investigated. DNB data were obtained on a single tube at 2000 psia pressure with uniform heat flux distribution and three nonuniform axial heat flux distributions: (1) Peak flux near the fluid inlet, (2) peak flux near the fluid outlet, and (3) peak flux at the center corresponding to early-in-life, late-in-life, and end-of-life reactor-core conditions, respectively. It was found that a heterogeneous water-cooled reactor core, safely designed to operate always under nucleate boiling conditions, must have the heat-flux distribution as well as the local heat-flux values properly accounted for as important design considerations. (auth)

12434 LOCAL BOILING PEAK HEAT FLUX FOR WATER FLOWING NORMAL TO CYLINDERS. Gary Clark Vliet. Thesis, Stanford, Calif., Stanford Univ., 1962. 155p.

An investigation was conducted on the peak heat flux as a function of liquid velocity and subcooling and of heater diameter for flow of water normal to direct-current heated cylindrical elements at atmospheric pressure. The ranges covered in the investigation were: $0.65 < V < 11$ ft/sec; $3 < \Delta t_{sub} < 100°F$; $0.010 < D < 0.189$ inch; and $0.6 \times 10^6 < q''_m < 9.0 \times 10^6$ Btu/hr ft^2. The results indicate that the peak heat flux varies approximately linearly with each of velocity and subcooling and inversely as the heater diameter to an exponent that is a function of both velocity and subcooling. The degree of subcooling markedly affects the two-phase flow near the peak heat flux. For subcoolings less than about 30°F, the cylinder wake consists of a vapor cavity into which liquid is fed by the two-phase boundary layer as it moves around the cylinder and separates near the 90 degree position. For greater subcoolings a two-phase boundary layer exists around the entire cylinder with a concentration of vapor near the 180 degree position. Near the 30°F subcooling condition, the peak heat flux exhibits a minimum, which becomes more evident with increase in velocity. Anomalous low results at high subcoolings were obtained near 5 ft/sec. The flow model suggested for low subcoolings is the basis of a quantitative analysis of the peak heat flux for saturated, forced-convection boiling from cylindrical elements. (Dissertation Abstr., 23: No. 6, Dec. 1962)

12435 HEAT TRANSFER WITH TURBULENT FLOW IN CONCENTRIC AND ECCENTRIC ANNULI WITH CONSTANT AND VARIABLE HEAT FLUX. Edward Yan Wood Leung. Thesis, Stanford, Calif., Stanford Univ., 1962. 241p.

The problem of heat transfer to fully established turbulent flow in concentric and eccentric annuli with constant and variable heat flux was investigated. Experimental apparatus was constructed for air flow in electrically heated circular tube annuli with radius ratios from 0.192 to 0.500. Experimentally determined coefficients of heat transfer with turbulent air-flow (Pr = 0.70) in concentric annuli with constant longitudinal heat flux from either surface are presented for the Reynolds number range of 10000 to 150000. Experimental data for the eccentric annuli experiments covered the radius ratio of 0.255 and 0.500, with the eccentricity parameter range from 0 to 0.92. The energy equation for a fully developed temperature profile and constant heat flux was integrated numerically, using assumed fully developed velocity and thermal diffusivity profiles based on the best available data in the literature. The analysis yielded heat transfer coefficients covering the radius ratio range from 0.10 to 1.0, the Prandtl number range from 0 to 1000, and the Reynolds number range from 10^4 to 10^6. Experiments for heating from both walls of the annular passage were conducted, and the results of the experiments are compared with the predictions of the superposition method. (P.C.H.)

12436 THE EFFECT OF PRESSURE TRANSIENTS ON BURNOUT IN POOL BOILING. John Reid Howell. Thesis, Cleveland, Case Inst. of Tech., 1962. 135p.

An investigation of the effect of pressure decay rates of the order of 5 to 10 psig/sec on pool boiling burnout in water was carried out. The initial system condition was saturation temperature at pressures of up to 62.5 psig. The pressure was allowed to decay to one atmosphere absolute at constant heat flux and the time to burnout of a stainless steel ribbon undergoing internal heat generation with surface heat fluxes of up to 5×10^5 Btu/hr ft^2 was measured. The results were correlated on the basis of the steady state curve of pressure vs burnout heat flux, which had also been determined for the system. It was found that a conservative prediction of time to burnout could be made by calculating the time from initial pressure release to the pressure at which steady state burnout would probably occur for the given initial heat flux. With few exceptions actual burnout occurred at longer times than this method would predict. Data obtained for various pressure decay rates, different initial pressures, and different internal generation rates are presented, and the effect of these parameters on the time to burnout and the relative data scatter is discussed. (Dissertation Abstr., 23: No. 6, Dec. 1962)

12437 PHYSICS OF HEAT EXCHANGE AND GAS DYNAMICS. A. S. Predvoditelev, ed. Authorized translation from the Russian. New York, Consultants Bureau Enterprises, Inc., 1963. 99p. $17.50.

Fifteen articles are presented, covering such topics as: detonations; shock waves in gases; gas properties behind shock waves; gas flows around obstacles; dissociation, combustion, and ionization in flows and shocks; heat transfer and friction properties of flows and shocks; and spectra of adiabatically cooled gases. (T.F.H.)

12438 IMPROVEMENTS IN STEAM RAISING SYSTEMS. Donald Edward Hartley (to Superheater Co. Ltd.). British Patent 912,710. Dec. 12, 1962. Filed Feb. 4, 1959.

A steam raising system of the once-through type was described comprising three or more concentric helically coiled tubes connected in parallel. Water flowed through the coils and hot fluid medium, such as the coolant gas of a gas cooled reactor, flowed over the coils. (C.E.S.)

12439 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. Frederick Carr (to Head Wrightson and Co., Ltd.). British Patent 915,627. Jan. 16, 1963. Filed Aug. 7, 1958.

A heat exchanger was described comprising at least one tube through which a gas to be cooled flowed and an outer container, surrounding the tube, containing a liquid, boiling liquid, or vapor. This invention provides a heat exchanger that alleviates or substantially reduces the effects of differential expansion that imposed stresses on the gas-carrying tubes. (C.E.S.)

12440 APPARATUS FOR DISTRIBUTING FLUIDS. Jean Verheyden (to Commissariat a l'Energie Atomique). British Patent 915,747. Jan. 16, 1963. Priority date Apr. 26, 1958, France.

A distributor apparatus was interposed between a single fluid inflow line and a plurality of outflow lines by which the fluid of the inflow line was passed to a selected outflow line, the invention having particular application to radioactive fluids. The apparatus did not have seals in contact with the fluid and therefore cannot leak. It required no maintenance and was suitable for remote control. (C.E.S.)

12441 IMPROVEMENTS IN OR RELATING TO VALVED DUCTING. Gordon Brown (to United Kingdom Atomic Energy Authority). British Patent 917,414. Feb. 6, 1963. Filed Sept. 10, 1958.

Coaxial valved ducting suitable for fluid flow to and from a heat exchanger provided counter-current flow of hot and cool fluids. A sleeve adjusted the aperture of both parts. (C.E.S.)

12442 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. Alan Bell (to Foster Wheeler Ltd.). British Patent 917,613. Feb. 6, 1963. Filed Dec. 14, 1960.

A heat exchanger is described that provides a large heat exchange surface for a given heat exchanger volume. The exchanger is particularly applicable to nuclear power plants where the amount of heat to be dissipated is very large. (C.E.S.)

12443 IMPROVEMENTS RELATING TO VAPOUR GENERATING AND SUPERHEATING APPARATUS AND TO A METHOD OF GENERATING SUPERHEATED VAPOUR. Norman George Worley (to Babcock and Wilcox Ltd.). British Patent 917,712. Feb. 6, 1963. Filed July 12, 1960.

A vapor generating and superheating apparatus was described for a nuclear reactor. The heat generated in the reactor was absorbed in part by heating a fluid to generate vapor from it and in part by heating a fluid circulated through the reactor. The fluid absorbed heat in the reactor and acted as a heating fluid in a heat exchanger. (C.E.S.)

12444 A GAS CIRCULATOR SYSTEM FOR EXTRACTING HEAT FROM A GASEOUS MEDIUM. Felix Sampson Heilbronn and Zeev Rotem (to English Electric Co. Ltd.). British Patent 918,097. Feb. 13, 1963. Filed June 27, 1958.

A heat exchanger consisted of a vessel through which the gaseous medium was circulated in heat exchange relation with a plurality of heat exchange tubes mounted within the vessel and arranged for connection to an external cooling circuit. (C.E.S.)

12445 A GAS CIRCULATOR SYSTEM FOR EXTRACTING HEAT FROM A GASEOUS MEDIUM. Felix Sampson Heilbronn and Zeev Rotem (to English Electric Co. Ltd.). British Patent 918,098. Feb. 13, 1963. Filed June 27, 1958.

The heat exchanger described is an elongated vessel through which the gaseous medium circulated with a plurality of heat exchange tubes connected to an external cooling circuit. The gas was drawn into the vessel and exhausted by means of a blower. (C.E.S.)

12446 IMPROVEMENTS IN OR RELATING TO TUBULOUS VAPOUR GENERATORS. Peter Anthony Taylor (to Babcock and Wilcox Ltd.). British Patent 918,246. Feb. 13, 1963. Filed Mar. 28, 1960.

A tubulous vapor generator with an inlet chamber and an outlet chamber within the pressure vessel and below the tube plate was described. The tubes of the bank were of inverted U-shape to improve the distribution of the heating liquid between the tubes. A substantially symmetrical vapor generation was obtained. (C.E.S.)

Materials Testing

12447 (TID-17812) NONDESTRUCTIVE ANALYSIS OF THE U-235 CONTENT OF NUCLEAR REACTOR FUEL ELEMENTS BY GAMMA RAY SCINTILLATION SPECTROMETRY. N. S. Beyer (Argonne National Lab., Ill.). Oct. 1962. Contract W-31-109-eng-38. 20p. (UAC-7005)

Rapid and nondestructive methods using gamma ray scintillation spectrometry techniques are available for assaying nuclear reactor fuel. Testing accuracy has kept pace with the demands of nuclear reactor technology. Basic techniques will continue to be used, but present developmental work will bring to light improved and more sophisticated methods. (auth)

12448 THE RAPID AND NONDESTRUCTIVE MEASUREMENT OF THE BULK DENSITY IN REFRACTORIES BY THE γ-RAY TRANSMISSION METHOD. Hiroshi Ohba. Seitetsu Kenkyu, No. 236, 3447-55(Sept. 1961). (In Japanese).

The possibility of using the γ-ray transmission method as a more efficient means for measuring the bulk density in refractories was tested. Gamma rays which emitted from a 10-mC Co^{60} source, passed through a collimator to the brick sample and entered the scintillator. Then the scintillation pulses were amplified linearly and counted by a scaler with a quartz-oscillator-type timer for 2-min periods. Better results were obtained by setting the linear amplifier to 1/10th of the discriminating voltage required to cut the γ-ray peak of 1.32 Mev. Results obtained from 5 types of bricks, (chrome, pyrophyllite, stabilized dolomite, silica, and fire clay) are given. Measurement required 5 to 7 min for each brick. (P.C.H.)

12449 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR TESTING TUBES FOR LEAKAGE AND METHODS OF CARRYING OUT SUCH TESTING. (to Calumet and Hecla, Inc.). British Patent 917,111. Jan. 30, 1963. Priority date Jan. 26, 1959, United States.

Apparatus for testing tubes for leakage and the methods of testing were described. A pressure differential method was used on a fluid under pressure to eliminate the undesirable features of the air-under-water test. (C.E.S.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

12450 (AFSWC-TDR-62-44) RADIOGRAPHIC INSTRUMENTATION STUDY. Final Report. F. H. Bloedow (American Machine and Foundry Co. Mechanics Research Div., Niles, Ill.). Apr. 1962. Contract AF29(601)-4154. 148p. (AD-277661).

Various radiographic techniques are examined and evaluated to determine their feasibility for the study of dynamic soil phenomena. The data, which could be obtained radiographically, are measurements of particle motion and density change as a function of position and time within the soil. The primary advantage of a radiographic system is that the condition of the soil is not modified by transducers within the soil, except for small pellets that have no measurable influence on the dynamic phenomena. Two specific radiographic systems are examined in great detail. They are used to observe dynamic phenomena in soil samples subjected to suddenly applied loads. One of these systems uses a steady source of x rays, and the other system uses a flash x-ray machine. The radiographic records from these tests are presented and analyzed. (auth)

12451 (CDRP-182-114) SPEARMAN'S FOOTRULE—AN ALTERNATIVE RANK STATISTIC. D. C. Kleinecke, H. K. Ury, and L. F. Wagner (California. Univ., Berkeley. Inst. of Engineering Research). Nov. 1962. Contract CD-SR-58-40. 28p.

A known but neglected rank statistic—Spearman's Footrule—is examined. Formulas are given for its mean and variance and the covariance with better known rank statistics. A thorough numerical description is given, including the exact sampling distributions for up to ten ranks when all permutations are equally likely and approximate results up to twenty. The statistic appears to be asymptotically normal but this has not been proven. (auth)

12452 (LA-2765) QUANTITATIVE MEASUREMENT OF GAMMA-RAY-EMITTING RADIONUCLIDES IN METEORITES. M. W. Rowe (Los Alamos Scientific Lab., N. Mex.). May 1962. Contract W-7405-eng-36. 100p.

The gamma spectra of 32 samples of 25 chondrites, 4 carbonaceous chondrites, and 9 achondrites were investigated using a large NaI (Tl) scintillation spectrometer. Potassium and Al^{26} were the predominant radioactivities measured. More unusual gamma emitters measured were 291-day Mn^{54}, 2.6-year Na^{22}, and probably a mixture of Sc^{46} and Co^{56+58} (half lives approximately 80 days); these nuclides were detected in relatively recent falls (the youngest, the Harleton, Texas, chondrite, was measured 21 days after fall). Furthermore, thorium was detected and measured in 5 of the 9 achondrites. Of the 6 siderites studied, only Aroos and Sikhote-Alin showed detectable gamma radioactivity. In Aroos, measured 120 days after fall, Mn^{54} was the predominant radioactivity; Co^{60} was the only radioactivity measured in the 4 samples of Sikhote-Alin. In the other 4 old siderites, with a limit of detection of about 10 gammas/min/kg, no gamma-ray activity in the energy range 0.2 to 2 Mev was detectable. Quantitative data on radioactive concentration are presented. (auth)

12453 (NYO-10393) STUDY OF TECHNIQUES FOR DETERMINING DISTRIBUTION OF RADIOACTIVE MATERIAL DEPOSITED IN THE UPPER ATMOSPHERE. Quarterly Status Report No. 3, September 20, 1962–December 20, 1962. (Geophysics Corp. of America, Bedford, Mass.). Contract AT(30-1)-2908. 13p.

The literature review of wind, diffusion, and circulation studies of the atmosphere above 30 km indicates the large void in our knowledge of mesospheric (55-80 km) and lower thermospheric (80-120 km) processes. The indirect inferences from the rhodium radioisotope analysis suggest a residence time of 10 ± 5 years for debris deposited at 100–150 km, which is the first real indication of the hold-up power of the mesosphere. Investigations of aerosols for use in mesospheric wind and diffusion experiments are being made. (auth)

12454 (RISÖ-45) OBSERVATION OF GAUSSIAN AND NON-GAUSSIAN TURBULENT VELOCITY DISTRIBUTIONS. O. Kofoed-Hansen (Denmark. Atomenergikommissionen. Forsøginstitut, Risø). Sept. 1962. 24p.

Smoke diffusion observations and measurements of wind velocity fluctuations are reported. In cases where the wind velocity fluctuation distributions are Gaussian, good agreement is obtained with the theory developed previously. Non-Gaussian wind velocity fluctuation distributions are reported, and it is shown in agreement with expectations that such situations cannot be described by the above-mentioned theory. (auth)

12455 (NP-tr-943) INVESTIGATION OF SAND MIGRATION IN THE REGION OF THE GERMAN COAST BY MEANS OF RADIOACTIVE TRACERS. Heinz Schulz and Gerhard Stroehl. Translated by W. Bleyberg (U.K.A.E.A., Research Group, Atomic Energy Research Establishment, Harwell, Berks, England) from Deut. Gewässerkundl. Mitt., 4: 17-27(1960). 47p. (Includes original, 9p.)

An investigation was made to determine the migration of sand in the coastal region of Germany by depositing a radioactive element on sand grains by chemical combination. The deposition of Cr^{51} in the form of Cr^{3+} in 1N HCl solution produced an accumulation of ~30%. The energy of the emitted γ radiation of Cr^{51} is 0.32 Mev, favoring the use of a scintillation probe as detector. Zero-effect radiation measurements were carried out in order to establish the level of natural radiation in the region being investigated. The results indicate that the migration of the sand does not proceed as a thin layer along the seabed. The actual sand conveyance is seldom equal to the potential sand transport deduced from the speed of the current. This procedure appears adept in usage in coastal waters extending over a wide area in order to establish locations with a tendency toward erosion or sedimentation. (H.G.G.)

12456 GEOPHYSICAL EFFECTS OF NUCLEAR EXPLOSIONS AT SODANKYLÄ. J. Oksman and E. Kataja (Finnish Academy of Science and Letters, Sodankylä). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 115, 1-27(1962). (In English)

Nuclear explosions at Novaya Zemlya in autumn 1961 caused pressure waves that could be detected all over the world. The two largest tests, on October 23 and 30, caused ionospheric disturbances at Sodankylä (distance from Novaya Zemlya about 1200 km) beginning with a large increase in f_0F_2 (ordinary wave critical frequency of the F_2 layer. The irregular behavior of f_0F_2 lasted for several hours. The propagation velocity of the irregularity in the ionosphere has been calculated using the data from Sodankylä and from some other stations: it is seen to decrease with distance from Novaya Zemlya. The irregularity in f_0F_2 could be detected again on the days following October 30

at Sodankylä, as well as at some other stations. This suggests that the explosion on October 30 caused ionospheric waves that travelled several times round the world with a travel time of about 24 hours. No clear geomagnetic effects have been detected. Seismic data from several explosions are given. (auth)

12457 EFFECTS OF DECOUPLING ON SPECTRA OF SEISMIC WAVES. D. E. Willis and James T. Wilson (Univ. of Michigan, Ann Arbor). Bull. Seismol. Soc. Am., 52: 123-31(Jan. 1962).

A series of controlled high explosive shots were conducted in a salt mine near Winnfield, Louisiana, to investigate seismic decoupling theories. Two recording stations were used at various distances between 1.1 and 14.7 kilometers for a majority of these shots. Frequency analyses of the magnetic tape recordings were made and the results are presented showing the relationship of the frequency spectra as a function of charge size, distance from the source, and coupled vs decoupled shots. The smaller decoupled shots detonated in the large spherical cavities were observed to have somewhat higher predominate frequencies than the equivalent size coupled shots. A change in cavity size produced no significant difference in the shape of the spectra of the large decoupled shots. (auth)

12458 RAPID MEASUREMENT OF N_2^+ ROTATIONAL TEMPERATURES IN AURORA. D. M. Hunten, E. G. Rawson, and J. K. Walker (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 41: 258-70(Feb. 1963).

A description is given of a photoelectric "temperature photometer," which gives a temperature reading from aurora in about one second. It uses two narrow-band interference filters to measure the intensity in two parts of the bright N_2^+ band at 3914 Å, and a third to allow a background measurement. The reading is presented on a meter and is independent of the auroral intensity over a wide range. Observations of aurora permit construction of a temperature profile for the atmosphere from 95 to 170 km, showing a gradient of 6.0°K/km. A lowest temperature of 140 ± 20°K is observed for a period of several minutes. Diffuse surfaces appear from their temperatures to occur anywhere from 100 to 160 km. (auth)

12459 CURVATURE AND INCLINATION OF STRATA IN THE EARTH'S CRUST IN RELATION TO SEISMIC AMPLITUDES OF HIGH EXPLOSIONS. Pierre Mechler and Yves Rocard. Compt. Rend., 255: 2490-2(Nov. 5, 1962). (In French)

The Saharan nuclear explosion of May 1, 1962, permits a description of the curvature of the Mohorrovicic discontinuity in the various azimuths around the explosion point to be obtained from an analysis of the long distance seismic amplitudes. (tr-auth)

12460 EFFECT OF THE HIGH ALTITUDE THERMONUCLEAR EXPLOSION OF JULY 9, 1962, ON THE RESONANCE OF THE EARTH-IONOSPHERE CAVITY. INTERPRETATION. Roger Gendrin and Robert Stefant (Centre National de la Recherche Scientifique, Paris and Institut d'Electronique, Orsay, France). Compt. Rend., 255: 2493-5(Nov. 5, 1962). (In French)

The lowering of the resonance frequencies of the earth-ionosphere cavity, subsequent to the thermonuclear explosion July 9, 1962, can be explained by an increase in the ionization of low levels of the ionosphere provoked by the penetration of high energy particles. A graphic method permits the order of magnitude in this increase to be obtained. (tr-auth)

12461 THE DEUTERIUM CONTENT OF HYDROUS MINERALS FROM THE EAST-CENTRAL SIERRA NEVADA AND YOSEMITE NATIONAL PARK. John D. Godfrey (Univ. of Chicago). Geochim. Cosmochim. Acta, 26: 1215-45(Dec. 1962). (In English)

The experimental procedure for the extraction of hydrogen from natural hydrous silicate minerals is outlined. The D/H ratios, water, and fluorine contents were determined for coexisting biotite, hornblende, and chlorite from rocks of the east-central Sierra Nevada and Yosemite National Park regions. These data are discussed in relation to the petrogenesis of the principal rock types of the region. Local hydrogen isotopic fractionation and equilibrium between coexisting hydrous silicates were noted. (auth)

12462 THEORETICAL AND TECHNICAL ASPECTS OF Rb–Sr GEOCHRONOLOGY. G. H. Riley and W. Compston (Univ. of Western Australia, Nedlands). Geochim. Cosmochim. Acta, 26: 1255-81(Dec. 1962). (In English)

The derivation of formulas used in Rb–Sr geochronology is treated analytically and graphically. Graphical representation is given for the following model situations which may represent at least the limiting cases for some of the more usual natural situations: all mineral and rock phases in an igneous body remain closed chemical systems since its first crystallization; the whole rock remains a closed system, but minerals are closed only since a subsequent metamorphism; and two rock or mineral phases of different ages are mixed to varying degrees. Some discussion of the implications of non-closure with respect to the isotopes Rb^{87}, Sr^{87}, and Sr^{86} is given. An analysis of the effects of laboratory contamination on the expected graphical age pattern is given for contamination sources of both spike and sample isotopic abundances. A formulation was made of the necessary analytical requirements for the conclusive determination of the age of initial rock crystallization using the Rb–Sr method only. Suggestions are made for dating metamorphisms using the contrasting models of complete local homogenization of Sr^{87} isotopic abundance among minerals, and partial or total loss of only radiogenic Sr, with no homogenization. (auth)

12463 DYNAMICS OF THE MAGNETOSPHERE. Stanley H. Ward (Univ. of California, Berkeley). J. Geophys. Res., 68: 781-8(Feb. 1, 1963).

The impedance concept, so often used in solving problems in electromagnetic theory, is considered as it might apply to the dynamics of the magnetosphere. Geomagnetic "microstorms," events usually given the label bps for "bay with pulsations and a sudden commencement," are used in discussing the "transfer impedance" of the magnetosphere. By this means we illustrate the relationship, in the frequency domain, between an assumed step-function change in the solar wind and an observed bps event. The transfer impedance so deduced is explained in terms of equivalent circuits. The circuit analogies are extended to include a unifying explanation of the origin of the micropulsations types pc and pt. Conclusions based on the application of statistical communication theory lead us to deduce possible mechanisms in the magnetosphere for the generation of micropulsation "signal" and "noise." The signal arises in "cavity" resonances of Alfvén waves both above and below the Alfvén wave velocity inversion and the noise in randomly distributed sources throughout the magnetosphere. Quasi-periodic modulation of micropulsations is attributed to the action of a random time distribution of discrete impulses, of solar wind velocity or density, in causing recurrent "ringing" of the resonant cavities. The damping of pt signals can be explained on the basis of absorption in the ionosphere and the lower boundary of the Alfvén wave velocity inversion. Presumably these damping processes are

not acting to the same extent in the day hemisphere as in the night. Some insight into the nature of the impulse response of the magnetosphere can be obtained at times of nuclear detonations in the upper atmosphere. This approach, though instructive, is limited because the forcing function is applied within rather than without the magnetosphere. However, the magnetograms at such times provide strong arguments in favor of the basic concepts introduced in this paper. (auth)

12464 SOME CHARACTERISTICS OF ELECTROMAGNETIC BACKGROUND SIGNALS IN THE VICINITY OF ONE CYCLE PER SECOND. J. E. Lokken, J. A. Shand, and C. S. Wright (Pacific Naval Lab., Victoria, B. C.). J. Geophys. Res., 68: 789-94(Feb. 1, 1963).

Near 1 cps the natural background consists of a comparatively steady, low-level, "white" continuum relieved occasionally by the intrusion of either regular or impulsive geomagnetic signals, as well as by the normal occurrence of sferics. The amplitude and frequency of the intrusions depend on latitude. Characteristic, regularly repeating signal-reinforcement patterns are sometimes observed in austral and boreal regions. Such patterns are displaced in time at conjugate points by one-half their repetitive period. (auth)

12465 ISOTOPE ABUNDANCES OF RARE-EARTH ELEMENTS IN METEORITES. I. IMPLICATIONS OF SAMARIUM, EUROPIUM, AND GADOLINIUM TO THE EARLY HISTORY OF THE SOLAR SYSTEM. V. Rama Murthy (Univ. of California, San Diego) and R. A. Schmitt. J. Geophys. Res., 68: 911-17(Feb. 1, 1963).

The isotope abundances of samarium, europium, and gadolinium have been measured in two normal chondrites, an achondrite, a carbonaceous chondrite, and a volcanic basalt originating from a depth of 40 km in the Kilauea-Iki vent in Hawaii. The meteoritic isotope abundances are similar to the terrestrial abundances within experimental errors, and "general" or "special" anomalies for these three elements in meteorites do not seem to exist. There is no depletion of the isotopes with large thermal-neutron capture cross section (Sm^{149}, Eu^{151}, and Gd^{157}) relative to the earth. With reference to a recent theory which attributes the terrestrial and meteoritic abundances of D, Li, Be, and B to spallation and thermal-neutron irradiation, our data can be discussed as follows: (1) the neutrons produced in spallation processes were not thermalized, so that the rare-earth isotope abundances were unaffected; (2) if the neutrons were thermalized, the ratio of irradiated material to nonirradiated material is exactly the same for the earth and meteorites; (3) there was no significant thermal-neutron irradiation. These three alternatives are discussed with reference to some recent studies of meteorites. (auth)

12466 THE CONJUGACY OF MAGNETIC DISTURBANCE VARIATIONS. Gary M. Boyd (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 1011-13 (Feb. 15, 1963).

Magnetograms from Eights, Antarctica, are compared with those taken at three close-spaced stations bracketing the calculated conjugate point in Quebec, Canada, and with records from other nearby stations in the northern hemisphere. A very close association among all variations save the S_q is found for the two-month period studied. Detailed analysis of the storm of January 10, 1962, yields the conclusion that the region of closest association may be localized to within a few tens of kilometers for such disturbances. (auth)

12467 TRAVEL TIMES TO AUSTRALIAN STATION FROM PACIFIC NUCLEAR EXPLOSIONS IN 1958. H. A. Doyle (Australian National Univ., Canberra) and J. P. Webb. J. Geophys. Res., 68: 1115-20(Feb. 15, 1963).

Travel times from the 1958 series of nuclear expolsions near Bikini and Eniwetok islands to Australian seismic stations are studied. For stations at distances between 25° and 63° the mean residual for P from the Jeffreys-Bullen times for a surface focus is -1.6 ± 0.7 sec, agreeing with travel-time determinations to other continents. Times to Rabaul (19° and 21°) strongly suggest a sharp bend in the P curve near 17°, corresponding to the "20° discontinuity." There is also a possible bend near 25° to 26 , but this would be less marked. Data are given. (auth)

12468 ON GEOMAGNETIC FLUCTUATIONS IN REGIONS REMOTE FROM HIGH-ALTITUDE NUCLEAR BURSTS. Edward C. Field (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 68: 1172-3(Feb. 15, 1963).

A suggestion that betas from decay of neutrons produced in high-altitude nuclear blasts can cause artificial geomagnetic solar flare effects in regions thousands of kilometers from the blast is made. An approximate expression for such a geomagnetic fluctuation is given. (D.C.W.)

12469 ISOTOPIC COMPOSITION OF STRONTIUM IN CARBONATITES. J. L. Powell, P. M. Hurley, and H. W. Fairbairn (Massachusetts Inst. of Tech., Cambridge). Nature, 196: 1085-6(Dec. 15, 1962).

To obtain information on the origin of carbonatites, the Sr^{87}/Sr^{86} ratios in twenty-one carbonatites and various dolomites and celestites are measured. The results indicate that carbonatites are not xenoliths of limestone, but are comagmatic with the alkaline rocks with which they are associated. That carbonatites contain juvenile CO_2 and are formed from a homogeneous subsialic source other than basalt magna is also indicated. (D.C.W.)

12470 STUDIES ON FALL-OUT PARTICLES. [PART] II. Tetsuo Mamuro, Kazuko Yoshikawa, Tadao Matsunami, Akira Fujita, and Toshio Azuma (Radiation Center of Osaka Prefecture). Nippon Genshiryoku Gakkaishi, 4: 860-6(Dec. 1962). (In Japanese).

Results obtained by γ spectrometry about the so-called fractionation effect (viz., that the radiochemical composition of highly radioactive fall-out particles is different from that of average fission products). Gamma spectra are shown of a filter-paper on which air-borne dusts were collected on Nov. 8, 1961, and of a highly radioactive particle found at that time. The radiochemical composition of the particle is strongly enriched in $Zr^{95} + Nb^{95}$ and impoverished in Ru^{103}, $Ba^{140} + La^{140}$, I^{131}, and $Ce^{141} + Ce^{144}$. Decay characteristics are shown of radioactivity of highly radioactive particles. Fractionation factors are calculated for many highly radioactive particles. The yield values for fast fission of U^{238} are used on carrying out the calculation of fractionation factors. Twenty-one of the highly radioactive particles are isolated from among non-radioactive dust particles. Relation is shown between particle radioactivity and fractionation factor for $Ce^{141} + Ce^{144}$, showing that particles of larger radioactivity are more affected by the fractionation effect. Fractionation factors for Ru^{103} are smaller than 0.1 for all the particles and those for $Ce^{141} + Ce^{144}$ are smaller than 0.6 for almost all of the particles. The fractionation effect is the most remarkable for Ru^{103} and seems to extend to much smaller particles for Ru^{103} than for $Ce^{141} + Ce^{144}$. An example is given showing the fractionation effect observed in rain water. From the test sample of small quantity in which the fractionation effect is remarkably observed, may be obtained a higher measured value of the concentration of fallout than that obtained from an average sample of much larger quantity. (auth)

12471 ATLAS OF THE AIRGLOW SPECTRUM 3000-12400 Å. V. I. Krassovskii (Inst. of Physics of the Upper Atmosphere, Academy of Sciences, USSR), N. N. Shefov, and V. I. Yarin. Planetary Space Sci., 9: 883-915(Dec. 1962).

An atlas of airglow spectrograms obtained in the USSR during the IGY is presented. (auth)

12472 JOULE HEATING AND TEMPERATURE IN THE UPPER ATMOSPHERE. Susumu Kato (Commonwealth Scientific and Industrial Research Organization, Camden, New South Wales). Planetary Space Sci., 9: 939-46(Dec. 1962).

Joule heating has been shown to be very effective in increasing electronic temperature in the upper atmosphere. It is found theoretically that the electronic temperature can rise up to several thousands °K soon after certain ionospheric current disturbances occur, while the temperature of neutral particles increases only very slowly. Temperatures in various conditions have been computed and are found to be compatible with observation. It is also possible that the high electronic temperatures may explain the excitation of certain auroral glows. (auth)

12473 A HYDROMAGNETIC THEORY OF GEOMAGNETIC STORMS AND AURORAS. J. H. Piddington (Commonwealth Scientific and Industrial Research Organization, Sydney). Planetary Space Sci., 9: 947-57(Dec. 1962).

A theory of geomagnetic storms, auroras and associated effects is further developed. It depends on motions in the Earth's exosphere or magnetosphere initiated by a combination of pressure and frictional drag of the solar wind and modified and extended by electric fields and currents in the ionosphere. Motion may be non-divergent, streamline flow opposed only by Lorentz forces in the ionosphere and not propagating to Earth, or divergent, non-streamline motion opposed by Lorentz forces in the Earth. The two types of motion are coupled in the E region where the former is identified with free flow of Hall current and the generation of non-streamline motion. The latter is identified with blockage of Hall current, the creation of a polarization field, and hence the generation of streamline motion. A theory of all components of a geomagnetic storm is given in terms of combination of these motions, and their distant, ionospheric and earth currents. This includes a new theory of the preliminary reverse part of the DS field and the transition from the sudden commencement to the main phase of the DS field. It is expected to introduce briefly a theory of auroras based mainly on ionospheric drifts caused by the magnetospheric motions. (auth)

12474 RADIOACTIVE FALL-OUT IN SADO ISLAND, JAPAN. Hideo Maruyama. Res. Rept. Nagaoka Tech. Coll., 1: No. 1, 57-66(Dec. 1962). (In Japanese)

The detected artificial radioactivity in rainfall of Sado Island was little or nothing until Sept. 1961. But after the reopening of the nuclear explosion tests by U.S.S.R. on Sept. 1961, radioactivity in rainfall increased, and especially since Oct. 21, highly radioactive spots were found in the open air. As a result of measurements for distribution, decay, and attenuation in Al filter, highly radioactive particles picked up from these spots were considered to be due to the successive large scale nuclear explosions. (auth)

12475 METEORITE AGES. Edward Anders (Univ. of Chicago and National Aeronautics and Space Administration, Greenbelt, Md.). Revs. Modern Phys., 34: 287-325(Apr. 1962).

Dating methods are reviewed for nucleosynthesis, melting of the meteorite parent body, cooling of the parent body, breakup of the parent body, and fall to earth of the meteorite. The actual ages measured are the terrestrial ages, the cosmic-ray exposure ages, the solidification ages, the "gas-retention" ages, and the extinct-radioactivity ages. The mechanisms by which meteorites trap primordial noble gases are described, along with the methods used to fractionate these gases. The preatmospheric sizes of meteorites are examined. (T.F.H.)

12476 THE DETERMINATION OF THE AGE OF THE ELEMENTS AND THE TIME REQUIRED FOR THEIR FORMATION. I. S. Panasyuk (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 141-2(July-Aug. 1961).

New statistics on radioactive decay are applied, and it is shown that the results of isotope analysis of the Richardton chondrite (stony) do not provide a basis for well-defined conclusions on the age of the elements and the time required for their formation. (auth)

12477 ON THE EFFECTS OF NATURAL AND ARTIFICIAL RADIOACTIVE AEROSOLS ON AIR ELECTRICITY ELEMENTS WITH RESPECT TO THE DEGREE OF AIR CONTAMINATION. Reinhold Reiter. Z. Aerosol. Forsch. u Therap., 8: 3-23(Jan. 1959). (In German)

It was established that a clear relation exists between natural radioactivity in air as well as the degree of the air contamination on the one hand and air electrical elements on the other, and that for heights between 700 and 3000 m no stopping point for the influence of artificial radioactivity in air on the air electrical elements can be found. This is shown to be valid for the scope of the measured concentrations of artificial radioactivity in the air in West Germany. Topics covered include: estimation of the available energies from natural and artificial radioactivity in the air for air ionization, measurement and recording data, influence of air radioactivity on the small ion count with regard to the air contamination, influence of air radioactivity on air conductivity and the air electric field at different heights, and a year's course of the air electric field and artificial radioactivity at 7 stations over several year's time. (M.C.G.)

12478 PROPAGATION OF STRONG EXPLOSION IN HETEROGENEOUS ATMOSPHERE. E. I. Andiankin, A. M. Kogan, A. S. Kompaneets, and V. P. Krainov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Prikl. Mekh. i Tekh. Fiz., No. 6, 3-7(Nov.-Dec. 1962). (In Russian)

Hydrodynamic calculations on strong explosions in heterogeneous atmospheres indicate the shock front expands upward into infinity. The shock wave in the strongest explosion does not exceed 16.5 km. The shock wave velocity and pressure were determined in relation to time. Formulas were developed for various energies and explosion heights. (tr-auth)

12479 PLANE DETONATION WAVES IN GROUND EXPLOSIONS. G. M. Lyakhov and Z. V. Narozhnaya. Zh. Prikl. Mekh. i Tekh. Fiz., No. 6, 124-7(Nov.-Dec. 1962). (In Russian)

Detonation waves near ground explosions were studied and correlations were made of plane and spherical wave parameters. The relation between wave parameters and water and air contents in the ground was determined. (R.V.J.)

12480 UNDERWATER EXPLOSIONS IN AIR HOLLOW. B. D. Khristoforov. Zh. Prikl. Mekh. i Tekh. Fiz., No. 6, 128-32(Nov.-Dec. 1962). (In Russian)

Measurements were made of shock wave parameters and bubble formation from underwater charges with density ρ =

1.6 g/cm^3 and specific gravity 0.4 to 2.5 in the center of a spherical air mass with radius 1.25 to 4.37 cm. Tests in the air-filled spheres were used to determine the influence of the magnitude of the source on the shock wave and bubble parameters. (R.V.J.)

12481 CRYSTAL STRUCTURE OF GAGARINITE. A. A. Voronkov, N. G. Shumyatskaya, and Yu. A. Pyatenko (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR and Inst. of Geology and Geophysics, Novosibirsk, USSR). Zh. Strukt. Khim., 3: 691-6(1962).

An x-ray diffraction analysis of gagarinite revealed a spatial group $C_{3i}^{4}-P\bar{3}$ with sharply expressed pseudosymmetry P63/m. The parameters are: a = 5.99 ± 0.03, c = 3.53 ± 0.02 Å, N = 1. Gagarinite has an impregnated UCl_3 structure. The initial formula for gagarinite is expressed as $Na_2Ca_2TR_3F_{15}$ with a general number of cations to anions 3 : 6 and the general gagarinite formula AB_2F_6. (R.V.J.)

12482 ON GAGARINITE FORMULA. Yu. A. Pyatenko and A. A. Voronkov. Zh. Strukt. Khim., 3: 720-1(1962). (In Russian)

Previously it was shown that gagarinite has a hexagonal structure of the $UCl_3-Y(OH)_3$ type. The TR (rare earth) + Ca are found in the place of U(Y) in the basic structure with a coordination number of 9. The general formula can be written as: $Na(TR, Ca, Na)_2F_6$ or $Na(TR_x, Ca_y, Na_z)_2F_6$, where the variations of the variables x, y, and z are: $1.0 < x < 1.5$; $0 < y < 1.0$, $0 < z < 0.5$. (R.V.J.)

12483 PRIMENENIE GEOFIZICHESKIKH METODOV DLYA POISKOV I RAZVEDKI MESTOROZHDENII RADIOAKTIVNYKH ELEMENTOV; BIBLIOGRAFICHESKII UKAZATEL' 1945-1957 gg. (Application of Geophysical Methods in the Search and Prospecting of Radioactive Element Deposits; A Bibliographic Guide, 1945-1957). Moscow, Gosgeoltekhizdat, 1960. 95p.

References and short abstracts are given on geophysical methods in prospecting and exploration for radioactive elements. (R.V.J.)

12484 GAMMA-LUCHI I NEITRONY V POLEVYKH POCHVENNOMELIORATIVNYKH ISSLEDOVANIYKH. TEORIYA I PRAKTIKA PRIMENENIYA GAMMA-LUCHVYKH I NEITRONNYKH METODOV. (Gamma Rays and Neutrons in Field Soil-Amelioration. Theory and Practical Application of Gamma and Neutron Methods). V. A. Emel'yanov. Moscow, Gosudarstvennoe Izdatel'stvo Literatury v Oblasti Atomnoi Nauki i Tekhniki, 1962. 224p.

The theory and applications of γ and neutron methods in soil amelioration investigations are analyzed. Portable radiometric equipment and safety measures in handling radioactive sources are discussed. The book is designed for geologists and hydrotechnicians. 83 references are included. (R.V.J.)

12485 PRIBORY DLYA GEOFIZICHESKIKH ISSLEDOVANII SKVAZHIN RADIOAKTIVNYMI METODAMI. (Radiometric Equipment for Geophysical Studies of Bore Holes). Kiev, Izdatel'stvo Akademii Nauk Urkrinskoi SSR, 1962. 191p.

Twenty-five articles are included on the efficiency, thermal stability, and improvement of radiometric well-logging equipment. Gamma-neutron and pulse methods are analyzed, and performance of various photomultipliers is discussed. A separate abstract has been prepared for one of the more significant articles. (R.V.J.)

12486 GAMMA-NEUTRON WELL-LOGGING FOR BERYLLIUM. A. K. Sen'ko and V. B. Sal'tsevich. p.15-22 of "Pribory dlya Geofizicheskikh Issledovanii Skvazhin Radioaktivnymi Metodami." Kiev, Izdatel'stvo Akademii Nauk Urkrinskoi SSR, 1962.

Gamma-neutron well-logging was carried out using an amplitude integral discriminator and a calculating scheme in a container lowered to 400 m and equipped with a γ emitter, slow neutron detector, pulse amplifier, and high-frequency source. Photoneutrons from $Be^9(n,\gamma)Be^8$ were recorded. (R.V.J.)

12487 EKONOMIKA RADIOMETRICHESKIKH METODOV V DOBYVAYUSHCHIKH OTRASLYAKH PROMYSHLENNOSTI. (Economics of Radiometric Method in Exploration of Natural Resources). G. F. Mikheev and N. G. Feitel'man. Moscow, Gosatomizdat, 1962. 167p.

An analysis was made of technical and economic efficiencies of nuclear geophysical prospecting and exploration for oil and gas deposits. (R.V.J.)

12488 GEOKHIMIYA URANA V ZONE GIPERGENEZA. (Geochemistry of Uranium in the Zone of Hypergenezis). L. S. Evseeva and A. I. Perel'man. Moscow, Gosatomizdat, 1962. 239p.

A review is given of uranium geochemistry. An analysis is made of the basic migration of U in the upper earth crust and of the dissolution and leaching of U by ground water. Geochemistry of uranium deposit oxidation and secondary distribution are also discussed. (R.V.J.)

12489 NUCLEAR WELL LOGGING METHOD. Serge A. Scherbatskoy (to Perforating Guns Atlas Corp.). British Patent 917,685. Feb. 6, 1963. Filed May 11, 1959.

A method for determining the nature of the strata penetrated by a bore hole was described. The characteristics of such strata were logged by analyzing the response to the formations penetrated to bombardment by nuclear particles. (C.E.S.)

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Refer also to abstracts 12070, 13725, 13726, and 13737.

12490 (ACR-72) AN EVALUATION OF THE NEED FOR FILTRATION SYSTEMS TO PROTECT SHELTERED PERSONNEL FROM RADIOACTIVE FALLOUT. (Office of Naval Research, Washington, D. C.). Naval Reserve Research Co. 3-9, Brookhaven National Lab., Upton, N. Y. May 1962. 19p. (AD-277677)

The hazards associated with situations involving acute radioactive contamination of the atmosphere and the need for air filtration systems to protect personnel in various types of structures in such situations are reviewed. Topics covered include: sources of airborne radioactive contamination, hazards of internal absorption of radiation, useful air filtration systems for protection against airborne radioactive contamination and detection and alarm systems. (M.C.G.)

12491 (CEA-2191) MACHINE A CONTROLER LES ESSUIE-MAINS EN BANDE DU TYPE ESSUIMATIC. (Machine for Controlling Band-Type "Essuimatic" Hand Towels). S. Cottignies and J. Ortiz (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). 1962. 23p.

A machine was designed to control the band-towels in the form of 40-m bands equipping the "Essuimatic" distributors. It controls automatically the α and β-γ activity. The towel is driven by motors and passes under Geiger-Müller counters and then between zinc sulphide scintillators in conjunction with photomultipliers. Two distinct counting systems measure the total activity deposited on the cloth and, in order to give an idea of the distribution of this activity, count also the number of marks, that is, the number of times that the counting rate of the probes is above a certain value. After the passage of the cloth it is thus possible to know whether the count corresponding to the whole band is greater than that due to just the counter movement, and also whether this counting rate was not occasionally greater than the average rate; it is thus possible to detect weak local contamination which could be missed in an overall measurement of the cloth. (auth)

12492 (CEX-61.4) EXPERIMENTAL EVALUATION OF THE FALLOUT RADIATION PROTECTION PROVIDED BY SELECTED STRUCTURES IN THE LOS ANGELES AREA. Z. G. Burson (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). [1962?]. Contract [AT(29-1)-1183]. 117p.

A study designed to provide a basis for estimating protection against fallout radiation was conducted on four diversified structures in the Los Angeles, Calif., area. A fallout radiation field was simulated by a single radioactive Co^{60} source, which was pumped at a uniform speed through a long length of tubing evenly distributed over the area of interest. Measurements of the radiation levels at selected points inside the structures were made with highly sensitive ionization-chamber detectors. Protection factors ranged from 10 to 2000 in a laboratory building, up to 10,000 in a family fallout shelter, from 50 to 150 in a police building, and from less than 10 to approximately 20 in a high school classroom. (auth)

12493 (CRER-1120) ENVIRONMENTAL SURVEYS FOR NUCLEAR POWER STATIONS. W. E. Grummitt (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1962. 13p. (AECL-1656)

A general review of pre-start-up and operational environmental surveys is presented. Mention is made of the results of the Great Lakes Institute program at CANDU. Experience at Chalk River and at NPD is discussed with particular reference to the types of samples that provide the most meaningful information. While total β radioactivity at Pembroke, downstream from the AECL Chalk River plant, is not significantly increased, it is shown that Cs-137, and possibly Sr-90, originating at the plant can be detected at Pembroke by radiochemical analysis. The concentration has never exceeded 3% of the maximum permissible concentration in water for the general population. (auth)

12494 (MMPP-S-1) DESIGN FOR A BLAST, FIRE, AND FALL-OUT SHELTER. Frederick G. Hammitt (Michigan. Univ., Ann Arbor. Michigan Memorial-Phoenix Project). Sept. 1962. 32p.

A shelter built in Ann Arbor, Mich., is described. This shelter is thought to be the result of a reasonable design compromise of protection factors for an area of type in which it was built. It is noted that protection from blast, fire, and fallout are of primary importance, and the optimum protection sought in a shelter depends on many factors the most important of which is the proximity of the shelter to possible targets and direction of the prevailing winds. (J.R.D.)

12495 (NP-12431) DEVELOPMENT OF A MEANS TO PROVIDE PROTECTION FOR THE EYES AGAINST THE DAZZLE EFFECTS OF NUCLEAR DETONATIONS. Quarterly Report No. 4, September 30–December 30, 1960. (Polacoat Inc., Blue Ash, Ohio). Jan. 1961. Contract DA19-129-QM1534(OI 5056). 22p.

The formulation of a phototropic-thermotropic system incorporated into a rigid gel media that is capable of producing an optical density of 4 and returning to its original transparent state in approximately 20 minutes is described, as is the formulation of a thin, expedient, relatively inexpensive, "one-way," throw-away type phototropic-thermotropic protective device. The attenuation of both ultraviolet and visible radiation by the atmosphere and its effect on phototropic systems are discussed. The minimum quantum yield to protect against retinal burns is calculated, and relevant kinetic data are presented. (auth)

12496 (NP-12463) RADIOLOGICAL DECONTAMINATION OF DRINKING WATER BY ION EXCHANGE. A LITERATURE SURVEY AND REPORT ON AN INVESTIGATION OF THE BEHAVIOR OF YTTRIUM-91 AND BARIUM-LANTHANUM-140. Gerhard Klein, Philip Harten, and Warren J. Kaufman (California. Univ., Berkeley. Sanitary Engineering Research Lab. and California. Univ., Berkeley. School of Public Health). Nov. 1962. Contract CDM-SR-60-58. 51p.

A study of probable radionuclide contamination of water from a nuclear blast reveals Y^{91} and $Ba^{140}-La^{140}$ to be among the most serious contaminants. Possible methods of decontaminating water (apart from central filtration plants) are explored, and ion-exchange methods are deemed most feasible. Theory and practice of ion exchange are discussed, and the merits of a few types of ion-exchange materials currently used are evaluated. Results of experi-

ments in ion-exchange decontamination of water are presented and are supplemented by laboratory studies of several natural and artificial exchange media. Data from these experiments are displayed, and their implications are noted. (D.C.W.)

12497 (NP-12540) SUMMARY OF FALLOUT MEASUREMENTS IN SWEDEN 1958–1962: TOTAL RADIOACTIVITY OF PRECIPITATION AND AIR AT GROUND LEVEL. G. Lindblom (Sweden. Försvarets Forskningsanstalt, Stockholm). Jan. 1963. 12p.

The monthly radioactive deposition and monthly averages of activity in air at ground level are reported for the period 1958 to 1962. Because of nuclear device testing in the vicinity of Nova Zemija, less than 1000 km from Scandinavia, special attention is directed to the day-to-day fallout variation. (J.R.D.)

12498 (RISÖ-51) ENVIRONMENTAL RADIOACTIVITY AT COPENHAGEN, FEBRUARY 1961–AUGUST 1962. J. Petersen (Denmark. Atomenergikommissionen. Forsøginstitut, Risø). Nov. 1962. 25p.

Measurement of environmental coastal radioactivity in the Copenhagen area is reported. Gross β measurements were performed on sea-water samples collected regularly since Feb. 1961 in Copenhagen Harbor and in the Sound. Data are included from radiochemical determinations, predominantly of Sr^{90}, on samples of sea-water, sea-plants, mussels, and fish. The purpose of the measurements was to investigate the radioactivity in the surroundings of Copenhagen with a view to possible visits by nuclear ships. (auth)

12499 (SCPRI(T)-80) CONTROLE D'UNE OPERATION A L'USINE HYDROELECTRIQUE EDF DU LARDIT. (Controle of an Operation at the EDF Hydroelectric Plant of the Lardit). R. Gardel (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). Oct. 29, 1962. 7p.

A study was made to determine the possible radiation hazards and contamination dangers from the tracer determination of water flow at the Lardit hydroelectric plant. The results showed that the tracer measurement of the flow with Br^{82} resulted in no contamination of the water above permissible levels. Also the injection of the tracer resulted in no radiation hazard to the tracer handler. Possible additional precautions were, however, suggested. (J.S.R.)

12500 (USNRDL-467) RADIOLOGICAL PROTECTIVE CONSTRUCTION. PRINCIPLES FOR THE PROTECTION OF FACILITIES AND THEIR INHABITANTS AGAINST FALLOUT. W. L. Owen (Naval Radiological Defense Lab., San Francisco). Jan. 8, 1962. 160p. (AD-275990)

A number of protective principles are presented which can be either incorporated into the design of new buildings or applied to existing buildings in order to protect their inhabitants against fallout. Topics covered include: protective construction and radiological defense, relative importance of nuclear explosion effects, description of nuclear weapon effects, principles of protection for facilities and personnel, application of protective principles in the design of new buildings, application of protective principles to existing buildings, and performance of radiological recovery methods. (M.C.G.)

12501 TODAY'S MEDICAL PROBLEMS IN IONIZING RADIATION. Charles L. Dunham (Public Health Service, Washington, D. C.). Bull. N. Y. Acad. Med., 38: 729-40 (1962).

It is emphasized that many noxious substances of occupational and environmental origin present far greater potential hazards than radiation exposure, and that their deleterious effects may be more subtle and less well-recognized than those of ionizing radiations. Various long-term serious effects of radiation are described, with reference to data obtained from studies of pioneer workers in radiology and Ra experimentation, Ra dial painters, personnel of atomic energy installations, exposed populations of Hiroshima and Nagasaki, and experimental animals. Protection of occupationally exposed persons is discussed, but it is concluded that the greatest concern today is for increasing levels of exposure to the general population. The relative influence of various sources of radiation upon the public is considered, with respect to industrial and medical x rays, waste disposal of nuclear processing plants, and fallout from weapons tests. (H.H.D.)

12502 SOURCES OF IONIZING EXPOSURE TO THE GENERAL PUBLIC. Merril Eisenbud (New York Univ., New York). Bull. N. Y. Acad. Med., 38: 741-4(Nov. 1962).

The 3 important sources of radiation exposure of the general population are discussed, namely, natural radioactivity, medical x rays, and fallout. From natural radioactivity in New York City individuals are exposed to almost 100 millirad per year. This is divided roughly into about 40 millirad from internal sources and about 60 from external sources. The internal component comes from K^{40}, C^{14}, and Ra. The actual levels of exposure due to natural radioactivity are quite variable. Comparison of the levels in parts of Brooklyn to those in Washington Heights showed a 20% difference. Reasons for this are given. Medical use of ionizing radiation is an important source that has increased steadily. In New York City it is estimated that the per capita dose from the diagnostic use of x rays was about 100 millirad per year in 1956. The dose from fallout to the skeleton or gonads averages 5 to 10 millirad per year, and the I^{131} dose to the thyroid is somewhat higher. From the 1961 Soviet tests it is estimated that the milk-drinking population received about 50 millirad of exposure to the thyroid from I^{131}. Hence fallout contributes about 5% of the total dose to the gonads and skeleton, and a higher fraction of the total dose to the thyroid. The largest component in which improvement can be made is the medical component, which is probably about equal in magnitude to the natural radioactivity. (P.C.H.)

12503 INGESTION OF FOODSTUFFS CONTAMINATED WITH RADIOACTIVE ISOTOPES. John H. Harley (Atomic Energy Commission, New York). Bull. N. Y. Acad. Med., 38: 745-9(Nov. 1962).

Hazards to the public of radioactive debris from weapons testing is discussed, particularly with regard to Sr^{90}, Cs^{137}, and I^{131}. I^{131} has a very short physical half life, and with most foods, particularly with frozen and canned foods, there is a considerable time lag from the time they are picked or harvested until they get to the consumer. Therefore, most of the radioiodine has decayed away. Milk is probably the only source from which radioiodine can get into man in any appreciable concentration. Very little Cs^{137} comes up through the soil, and when it falls out, is absorbed very strongly by soils, and is not taken up very well by plants. However, there is direct contamination and, again, the route to man is very largely through the milk chain. Also, there may be considerable absorption from meat because cattle incorporate Cs^{137} in soft tissues. In the average diet about half of the Sr^{90} that is ingested comes from milk, one-fourth from grain, and another fourth through vegetables. (P.C.H.)

12504 EXPOSURE OF PATIENT AND PHYSICIAN BY DIAGNOSTIC AND THERAPEUTIC DEVICES. Norman Simon (Mount Sinai Hospital, New York). Bull. N. Y. Acad. Med., 38: 750-2(Nov. 1962).

It is estimated that the average gonadal dose of the population from radiotherapy is about 1% of the gonadal dose due to diagnostic x rays. However, evidence indicates that radiation effects on genes cause a proportional mutating effect no matter how low the dose. Estimations of gonad dose from diagnostic x-ray exposure suggest the average dose ranges from 16 to 170 millirad per yr, just about the same as natural background. The doubling dose for mutations is estimated to be about 50 rad while medical x ray gives the gonads only 3 rad (100 mrad per yr for 30 yr). It is also estimated that only about 10% of congenital deformities could be due to radiation; some mutations caused by radiation will prevent reproduction and never manifest a deformity. It was concluded that modern diagnostic x-ray examinations of patients cause no reported, discernible somatic effect, and the threshold for the effects may be even higher than the doses received with diagnostic x rays. Genetic effects may, however, occur from gonadal radiation, and for that reason it is necessary to minimize gonadal radiation. (P.C.H.)

12505 HANDLING OF PATIENTS CONTAMINATED BY OR EXPOSED TO RADIOACTIVE ISOTOPES AND IONIZING RADIATION. Roy E. Albert (New York Univ., New York). Bull. N. Y. Acad. Med., 38: 753-5(Nov. 1962).

There are 2 general classes of exposure to ionizing radiation: external sources, such as x-ray machines, accelerators, or radioisotopes present on the skin or at a distance; and secondly, from internal deposition of radioisotopes. The reduction of exposure from surface contamination involves cleansing the skin as efficiently and as rapidly as possible. In case of mixed fission product decontamination, potassium permanganate is sometimes helpful. A good decontaminating agent, in addition to having a high removal efficiency, should not abrade the skin, nor drive the radioisotopic surface deposit inward through the skin. The removal of internally deposited radioisotopes is more difficult. In the case of ingestion of a soluble radioisotope, it would be of benefit, theoretically, to convert it to insoluble form by feeding a suitable nontoxic precipitating agent, but in practice this is of doubtful value. Once having gotten into the circulation and deposited in specific organs, the removal of radioisotopes can be accomplished to a limited extent by the intravenous use of chelating agents, which react with the radioisotope and render them chemically inert, thus facilitating their urinary excretion. (P.C.H.)

12506 ARE MINIMAL AMOUNTS OF ROENTGEN RADIATION DANGEROUS FOR MAN? Werner Lorenz (Johannes Gutenberg Universität, Mainz). Deut. Med. Wochschr., 86: 470-3(Mar. 17, 1961).

From a consideration of probability factors, natural levels of radiation, and recommended international maximum permissible doses, it was concluded that diagnostic roentgenography presents little or no hazard to man. As an example, chest fluoroscopy is cited in which the gonads receive ~0.15 Mr. The probability of this causing a gene mutation is 1 in 10^{10}, and for the bone marrow, which would receive ~0.1 r, the probability of induction of leukemia would be 1 in 10^{7}. This is in contrast to a probability of 1 in 10^{3} of detecting a hitherto undisclosed case of pulmonary tuberculosis. These probabilities are also insignificant when compared with the spontaneous germ cell mutation rate (1 in 50000) and leukemia rate (1 in 20000). As a rough scale of the maximum allowable doses for various tissues during diagnostic radiography, the following is proposed: embryo 1 r, fetus 3 r, gonads 10 r, bone marrow and eye lens 100 r, skin (acutely irradiated) 1000 r, and skin (fractionally irradiated) 10000 r. (P.C.H.)

12507 RADIOACTIVITY IN RAIN WATER IN BANGKOK. Yen Sundara-vicharana, Swang Bhodigen, and Vichai Hayodom (Chulalongkorn Univ., Bangkok, Thailand). J. Natl. Res. Council Thailand, 2: No. 4, 25-36(Dec. 1961). (In Siamese)

In order to check the effect of nuclear explosions on the atmosphere over Bangkok, rain water was evaporated and the radioactivity of the residue obtained was counted by a G. M. counter. The result shows that the radioactivity in the rain water began to rise from the normal level since 26 September 1961, reached the maximum on 10 November 1961, and then slowly declined. Because the level of radiation remained above that of the Maximum Permissible Concentration (MPC) for only a short time, it did not constitute a health hazard. Analysis of the residue of rain water indicates that the increase in radiation is caused by the fall-out from the Russian tests of nuclear weapons in the air from September to October 1961. (auth)

12508 PHYSICAL CONTROLS IN THE PROTECTION OF WORKERS EXPOSED TO IONIZING RADIATION. Claudio Garavaglia (Università, Milan). Med. Lavoro, 53: 568-75(1962). (In Italian)

A description is given of the physical controls used in radiation protection, to show and measure the level of radiation in working sites, and the external and internal contamination by radioisotopes. The physical controls were divided into controls of the environment and of the workers: the first comprise controls of external radiation levels, of the contamination of the body, and the internal contamination. (auth)

12509 SYSTEMS ANALYSIS APPROACH TO THE EVALUATION OF HEALTH HAZARDS DUE TO AIR CONTAMINANTS IN THE DEVELOPMENT AND DEPLOYMENT OF THE FLEET BALLISTIC MISSILE WEAPON SYSTEM. H. David Baldridge, Jr. (Bureau of Naval Weapons, Washington, D. C.). Military Med., 127: 804-9(Oct. 1962).

Health hazards encountered in the operation of nuclear-powered fleet ballistic missile (Polaris) submarines are discussed. Methods and apparatus for removing toxic materials generated while the submarine is submerged are described. Elimination of carbon monoxide in particular is considered. Various methods for detecting atmospheric contamination as well as criteria for evaluating maximum allowable air concentrations are also considered. The approach and procedures employed to effect the toxicological control in submarines are directly applicable to other rapidly developing systems, such as in the design of manned space vehicles. (P.C.H.)

12510 STUDIES ON THE HEALTH STATUS OF THE POPULATION OF A SMALL AGRICULTURAL COLONY IN A REGION WITH INCREASED RADIOACTIVITY. J. Maršálek, Č. Mueller, and M. Kubát (Factory Inst. of National Health and Inst. of Work Hygiene and Occupational Disease Prevention, Vejprty, USSR). Neoplasma, 9: 593-6(1962). (In English)

The effect of increased radioactivity of environment was studied using the records of births from the years 1785 to 1949 and registers of deaths from 1862 to 1946, in the former village of Popov, in the region of Jáchymov, on the health status of the permanent population employed in agriculture. The assessed whole-life doses of ionizing radiation exceeded those usually found and those allowed by international standards. The average age of the popula-

tion was not shorter. No malformations of newborn babies were recorded and infantile mortality was conformable. The proportion of newborn boys to newborn girls was 1:1, which is unusual. (auth)

12511 RADIATION DOSE FROM Hg^{203}-LABELED TEST COMPOUNDS IN RENAL DIAGNOSIS. Gerhard Kloss (Universität, Bonn). Nucl. Med., 3: 82-9(1962). (In German)

Recently Hg-203 labeled compounds were introduced in the isotope diagnosis of renal disease. The calculation of the radiation dose caused by radiosalyrgan, based on results obtained in typical cases, showed an average dose to the gonads in males of 0.018 and in females of 0.060 rad following administration of 100 μC of Hg^{203}. For neohydrin the corresponding values were 0.028 and 0.075 rad, respectively. In addition, both total body and renal radiation doses were determined for both compounds. Several observations indicated that salyrgan could perhaps be used for both renography and renal scanning. If used in the latter procedure, a dose to the gonads twice that resulting from neohydrin would have to be expected. However, even in that case the higher dose to the gonads would still be only half of the x-ray dose resulting from pyelography. If salyrgan is used in renography, then considerably smaller amounts need to be administered so that the radiation dose would be only one-fortieth or one-hundredth of that due to the radiological procedure. The values for radiation doses to the gonads, the whole body, and the kidneys were compared with relevant data from the literature. (auth)

12512 RADIATION PROTECTION MEASUREMENTS IN A 2000-CURIE Co^{60} IRRADIATION INSTALLATION. P. Koeppe (Freie Universität, Berlin). Nucl. Med., 3: 109-17(1962). (In German)

The results of measurement of the dose rate in the radiation room of a Co^{60} therapeutic unit and in the adjacent rooms are presented. (auth)

12513 RADIATION ACCIDENTS. Arlene M. Putt (Univ. of Arizona School of Nursing, Tucson). Nursing Outlook, 9: 350-1(June 1961).

A plan for handling radiation accidents in hospitals is outlined. All rooms used in examination and treatment of radioactive persons must be surveyed by the hospital radiation officer, before being used for other accident cases. Following emergency treatment, the patient is transported to the clinical radioisotope unit. If he has sustained surface contamination only, he is decontaminated by scrubbing with soap and water before he is admitted for observation. If the radioactive contaminant was ingested or inhaled, he is admitted to a private room in which personnel who care for him must observe specific controls. This includes working at a distance from the patient whenever possible, staying at the bedside for no longer than the time specified, and checking of linen and excreta for radiation. The precautions are reviewed daily and changed as deemed safe. As the radiation hazard decreases, the time personnel are permitted with the patient increases. The patient is isolated until he is no longer a source of a significant amount of radiation, at which time he is released from isolation by the radiation control officer. (P.C.H.)

12514 ENVIRONMENTAL DOSIMETRY CONCERNING RADIOLOGIC SERVICE IN HOSPITALS. F. De Simone, G. D. Martina, and P. Tripodi. Rass. Med. Ind., 31: 194-217(May-June 1962).

Results of dosimetric researches carried out on radiologic installations in one of the principal Roman hospitals relative to the reorganization of radiologic protection in the Ospedali Riuniti (Joined Hospitals) are reported. Proper considerations on the present state of knowledge and system of organizing the defense of the personnel exposed to hazards of ionizing radiation were made. (Public Health Eng. Abstr., 43: Nos. 1-2, Jan.-Feb. 1963)

12515 PERMISSIBLE EXPOSURE TO IONIZING RADIATION. Karl Z. Morgan (Oak Ridge National Lab., Tenn.). Science, 139: 565-71(Feb. 15, 1963).

Hazards from exposure to radiation are discussed. Sources of natural radiation are described. Early records of damage to man by ionizing radiation are summarized. The establishment of national and international standards for maximum permissible exposure (MPE) to radiation is reviewed. Considerations in the selection of MPE values are outlined, and units are defined. (M.C.G.)

12516 RADIOAKTIVNYE ZAGRYAZNENIYA VNESHNEI SREDY. (Radioactive Contamination of the Environment). V. P. Shvedova and S. I. Shirokova. Moscow, Gosatomizdat, 1962. 275p.

Selection and preparation of specimens for radiochemical analysis were surveyed. Radiochemical determination of long-life fission products in various media, identification of individual isotopes, dosage determination for fallout contamination, distribution of global fallout, and Sr^{90}, Cs^{137}, and Ce^{144} fallout and contents in surface soils, water, and food are discussed. An analysis was also made of long-life fission products migration in soil and ground waters. (R.V.J.)

12517 INDEMNITY AND REACTOR SAFETY. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SEVENTH CONGRESS, SECOND SESSION ON APRIL 10 AND 11, 1962. (United States. Congress. Joint Committee on Atomic Energy). 1962. 203p.

Hearings were held before the Subcommittee on Research, Development, and Radiation of the Joint Committee on Atomic Energy concerning the liability and indemnity field and reactor site criteria. Current reactor safety problems were discussed. (H.G.G.)

12518 AEC REGULATORY PROBLEMS. HEARING BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SEVENTH CONGRESS, SECOND SESSION ON APRIL 17, 1962. (United States. Congress. Joint Committee on Atomic Energy). 1962. 114p. $0.35(GPO)

A hearing by the Subcommittee on Legislation of the Joint Committee on Atomic Energy of the 87th Congress of the United States was held on April 17, 1962, to receive information on operations in the AEC regulatory program for the preceding year and to determine what measures are necessary to simplify regulatory procedure and to alleviate present regulatory problems regarding safety, licensing, inspection, etc. (H.G.G.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

12519 (NYO-9852) UTILIZATION OF RADIOACTIVE ISOTOPES IN COAL PROCESS RESEARCH. Final Report – III, June 1, 1961 – May 31, 1962. P. M. Yavorsky and E. Gorin (Consolidation Coal Co. Research and Development Div., Library, Penna.). May 31, 1962. Contract AT(30-1)-2350. 58p.

The use of radiotracers was demonstrated in detailed studies of coal cleaning or pyrite removal in hydraulic fluidization and in hydroclones. The tracers are neutron activated coal-pyrite particles of numerous sizes and densities. Tracers are located or observed by gamma radiation from Fe^{59} and Sc^{46}, the principle radioisotopes. The tracer results show definite density-based particle segregation in fluidized beds, as well as size-segregation. Segregation rates in a fluidized coal bed, for a wide range of particle densities and sizes, are empirically correlated to their settling rates in water. The data are useful for the design of commercial fluidized-coal cleaning units. Illustrative results are given which show the cleaning efficiency obtained with fluidized cleaning of a Pittsburgh Seam coal for a specific case. Efficiency of pyrite-particle segregation in a hydroclone was measured by radiotracing showing the dependence upon particle density, particle size and slurry concentration. Such data are collected more rapidly by radio-tracing than conventional analyses. (auth)

12520 ON THE APPLICATION OF GAMMA RAY SPECTROMETRY TO THE SIMULTANEOUS RECORDING OF WEAR FROM CHROMED PISTON RINGS AND CYLINDER LINERS. B. Fogagnolo, C. P. Galotto, U. Lo Conte, and G. Mannone (FIAT, Turin). Energia Nucl. (Milan), 10: 29-33(Jan. 1963). (In English)

A method is described for the simultaneous measurements of wear of chromed piston rings and cylinder liners in a reciprocating engine. One engine test showed the influence of test variables on wear with drastic reduction in the operating time required and no need to repeat test conditions in three separate runs. A three-channel spectrometer to detect Cr^{51} and Fe^{59} from irradiated piston rings and Ru^{103} melted into a cast iron plug fitted in the cylinder liner was used. The equations for evaluating the three isotopes build up in the lubricant oil were established and solved. (auth)

12521 RADIOISOTOPE USES IN THE TREATMENT AND DISTRIBUTION OF WATER SUPPLIES. Herbert W. Feely (Isotopes, Inc., Westwood, N. J.), Alan Walton, and Charles R. Barnett. J. Am. Water Works Assoc., 55: 193-9(Feb. 1963).

A review is presented of the applications of radionuclear technology in research on improvements in water supply and waste disposal practices. Among the applications are analyses, disinfection, leak detection, and flow measurement. Possible future applications are discussed briefly. (D.L.C.)

12522 THE APPLICATION OF RADIOISOTOPES IN THE CONSTRUCTION OF RAILROADS AND HIGHWAYS. D. Ciumedean. Rev. Cailor Ferate, 10: 125-30(Mar. 1962). (In Romanian)

A method for the control of the substructure of railroads and highways by radioisotopes is given. A brief introduction is given on the principles of radioactivity, and an explanation is given on the way in which neutrons as well as various forms of radiation emitted from radioisotopic material can be used for structure control. The measurement of soil and surface humidity can be carried out by using neutron scattering. Sondes, equipped with a neutron source in the head and suitable detecting devices in the upper part, are used to measure the humidity in depth, while neutron scanning devices determine the surface humidity. The degree of compactness, density, and fine structure of the foundation layer can be determined with γ rays using Co^{60} as the radiation source. The apparatus employed can be constructed to give a continuous recording of changes in compactness and other essential factors controlling the stability of railroad and highway foundations. The accuracy of density obtainable by γ rays is 0.03 g/cc. (P.C.H.)

12523 PROXIMITY DETECTION BY MEANS OF RADIOISOTOPES, THEIR USE FOR THE CONTROL OF OVERHEAD CRANES. J. Guizerix (Centre d'Etudes Nucleaires, Grenoble, France). Tech. Mod., 54: 189-92 (Apr. 1962). (In French)

Information is given on the use of radioisotopes to prevent the collision of 2 bodies, to control the movement of one body, or to maintain a constant distance between both. An often encountered example is that of the overhead crane, which has to be used when the visibility is poor. For proximity measurements of overhead cranes, Co^{60} (180 mC) or Cs^{137} (1 C) can be used as radiation sources, and a Geiger counter is preferred as the detector because of its stability and lower price. The proximity is measured by the variation of the solid angle from which the detector sees the source and from which a direct conclusion may be drawn as to the distance of the 2 objects. The counter is connected with electronic equipment, which transforms the pulses into distance readings and operates a controlling device by means of relays. (P.C.H.)

12524 AN EXPERIMENTAL SEMI INDUSTRIAL γ-UNIT GUEP-20.000. A. V. Bibergal, T. V. Tsetskhladze, and I. D. Artmeladze. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 63-74(1962). (In Russian)

An experimental semi-industrial γ-unit, GUEP-20.000, is described. It can be used both to irradiate different objects and to make investigations of a radiation-biological character in uniform dose field. (auth)

12525 KILLING SILKWORM COCOONS BY IRRADIATION. T. V. Tsetskhladze. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 103-7(1962). (In Russian)

The results of investigations of silkworm cocoon killing by irradiation are given. It is shown that the method is a very perspective one. Its industrial realization will give both increased raw silk yield and improved dynamometric characteristics of silk thread. (auth)

12526 THE DEVELOPMENT OF RADIOISOTOPE PRODUCTION AND APPLICATIONS IN FRANCE. Y. Jolchine. Preprint S3-06. Prepublication Copy. 28p.

The production of radioisotopes by French reactors from 1949 to 1962 is tabulated. The use of isotopes in the medical field is reviewed. The major industrial applications for radioisotopes are thickness and level gages and gamma radiography, and these are discussed. Radioisotope applications in the steel, chemical petroleum, glass, textile, and coal

mining industries are outlined. The scope of the Radioisotopes Division of the Directorate of Materials and Nuclear Fuels is reviewed, and the building in which the Division operates is described, including hot cells, working boxes for chemical separation processes, ventilation, and liquid effluent ducts and tanks. (M.P.G.)

12527 THE PROSPECTS IN INDUSTRY OF IONIZING RADIATIONS. P. Leveque, F. Balestic, A. Lamm, and J. R. Puig. Preprint S3-05. Prepublication Copy. 19p.

Some industrial applications in the fields of physics and biology of ionizing radiations at power levels of ~1 kw are briefly mentioned. Possible and actual chemical applications are discussed in more detail, including irradiation of latex and solid rubber, polymerization of plastics, and radiosynthesis of organic molecules. The cost of industrial irradiations using nuclear reactors, radioactive sources, electron accelerators, and irradiated fuel rods is compared. (M.P.G.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 12193 and 13654.

12528 (KAPL-M-RFS-3) THE DIODE DIVIDER IN AN ANALOG DIVIDER, MULTIPLIER AND SQUARE-ROOT EXTRACTOR. R. F. Shea (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 9, 1962. Contract W-31-109-eng-52. 26p.

A semiconductor diode provides a means of obtaining a dynamic resistance inversely proportional to its d-c current. If this variable resistance is used as part of an a-c divider, the output will be proportional to the quotient of a-c input to d-c input. Two such dividers may be combined to provide multiplication where one divider provides the d-c input to the second. By using the a-c output to provide the a-c input, a square root may be obtained and if two dividers are used as a multiplier, this technique will provide the square root of the product. The application of this technique to the measurement of mass flow is illustrated. (auth)

12529 (KR-32) IMPEDANCE VOID METER. I. Oerbeck (Norway. Institutt for Atomenergi, Kjeller). Nov. 1962. 48p.

Methods for making steam void fraction measurements essential to design of water-moderated boiling reactors are discussed, and the in-core system used to measure transient void content in fuel assemblies of the Halden reactor is described. The electrical impedance increase between two electrodes in water as the water is partially replaced by vapor is measured. The gauge operates at temperatures up to 250°C and pressures up to 40 atm with an overall void meter frequency response of 100 c/s and an expected total error in fraction reading of $\pm(0.01 + 0.05\,\alpha)$. Sources of error are examined, and application of the method is illustrated. Results and schematics of the system are given. (D.C.W.)

12530 (SCTM-134-62(72)) LINE VOLTAGE LIMITER. R. L. Shaum (Sandia Corp., Albuquerque, N. Mex.). June 1962. Contract [AT(20-1)-789]. 10p.

A line voltage limiter is described for application where it is desirable to protect equipment from overvoltage transients, thus preventing consequent equipment failure or outage due to fuse blowing. Since the limiter is a specific protective device and is not required to compensate for undervoltages or to restore wave form, a considerable economy per unit is realized both in fabrication and in operation. (auth)

12531 (UNC-5000) DEVELOPMENT OF A CONTINUOUS METER FOR OXYGEN IN SODIUM. Quarterly Progress Report, September 1–December 1, 1961. H. Steinmetz (United Nuclear Corp. Development Div., White Plains, N. Y.). Jan. 15, 1962. Contract AT(30-1)-2877. 16p.

An electrochemical method for monitoring sodium for its oxygen content is outlined. The cell M, $MO|ZrO_2 + CaO|Na, Na_2O_{Na}$ is used as the basis for an oxygen monitor. M and MO represent, respectively, a suitable metal and its oxide and Na_2O_{Na} represents oxygen dissolved in sodium. A thermal convection loop, suitable for providing a high temperature zone to contain the electrochemical device, and a low temperature cold trap to control oxygen content was designed and constructed. This loop permits independent variation of temperature and oxygen content for evaluation of the electrochemical oxygen monitor. Gas tight, calcia stabilized, zirconia tubes were obtained. These tubes were found to function as solid ionic electrolytes when in contact with molten sodium. Voltage measurements were made with this system. (auth)

12532 (UNC-5010) DEVELOPMENT OF A CONTINUOUS METER FOR OXYGEN IN SODIUM. Quarterly Progress Report, December 1, 1961–February 28, 1962. H. Steinmetz (United Nuclear Corp. Development Div., White Plains, N. Y.). Apr. 15, 1962. Contract AT(30-1)-2877. 15p.

Experiments have shown that it is possible to monitor the concentration of sodium oxide dissolved in liquid sodium by an electrochemical method. The electrochemical cell consists of a metal-metal oxide electrode, a calcia-stabilized zirconia electrolyte, and an electrode of sodium containing the dissolved sodium oxide whose concentration the cell determines. In these experiments, the oxygen content of the sodium in a thermal convection loop was controlled by the temperature of the cold trap. It was found that the response of the electrochemical device, containing stabilized zirconia, at 550°F is greatly improved over the response at 800 to 1200°F. (auth)

12533 (UNC-5032) DEVELOPMENT OF A CONTINUOUS METER FOR OXYGEN IN SODIUM. Final Report, September 1, 1961–July 31, 1962. H. Steinmetz (United Nuclear Corp. Development Div., White Plains, N. Y.). Aug. 24, 1962. Contract AT(30-1)-2877. 35p.

An electrochemical method for monitoring sodium for its oxygen content has been shown to be feasible. The cell M, $Mo|ZrO_2 + CaO|Na, Na_2O(Na)$ was used. M and MO represent, respectively, a suitable metal and its oxide and this combination is used as the reference electrode. $Na_2O(Na)$ represents oxygen dissolved in sodium. Various reference electrodes were tested for stability and temperature coefficient. Of these, a reference electrode of copper and cuprous oxide powder proved to be the most stable. The electrochemical cell functioned well as an oxygen monitor in the range of 550 to 650°F, but reaction of the zirconia with sodium at higher temperatures interfered with cell function. (auth)

12534 (FTD-TT-62-1495) THEORY OF PULSE COUNTERS AND ITS APPLICATION. Zdenek Koutsky. Translated from Apl. Mat., 7: 116-40(1962). 27p.

A model of a pulse counter with k positions (conditions) is described. This pulse counter is nonsymmetrical, i.e., it can have various periods of relaxation in various positions and in different positions for transition into next position it must have different pulse levels. The pulse sources are described by Poisson's processes. Special attention is devoted to the study of boundary distribution of pulse number as well as the results which may affect the formulation of the number of probabilities by physical means. The pulse sources are independent from each other and possess various pulse levels. (auth)

12535 (FTD-TT-62-1529) A DEVICE FOR MEASURING ION CURRENTS IN MASS-SPECTROMETER CIRCUITS. V. I. Rakhovskii (Rakhovskiy), A. P. Lyubimov, and S. I. Pavlov. Translated from U.S.S.R. Patent 144559 (685696126). Nov. 15, 1960. 5p.

A device using only one photomultiplier dynode to convert

ion current into electron current offers higher accuracy and simplicity in measurements of ion currents in mass spectrometer circuits. Operation and design of the device to be used in measurements of ion currents with an order of magnitude of 10^{-16} to 10^{-17} amps are briefly discussed. (D.C.W.)

12536 THE VACUUM VIBRATOR AS A SOURCE OF IONS FOR MASS SPECTROSCOPY. V. S. Venkatasubramanian and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 234-9(Feb. 1963).

The metallic ions produced in the arc that occurs when a contact is broken in a vacuum are studied. The energy spread among such ions is significantly smaller than for the ions produced in a vacuum spark. Also, the relative ionization efficiencies for both singly and doubly charged ions can be greatly different in the two cases. The vacuum arc may prove of use in solid-source mass spectroscopy. (auth)

12537 NOVEL TEST TECHNIQUES MEASURE Q IN CRYOGENIC RESONANT CIRCUITS. William H. Hartwig (Univ. of Texas, Austin). Electronics, 36: 43-7(Feb. 22, 1963).

Three new measurement circuits operating by time-delay methods, elapsed-time methods, and R-C bridge methods have been developed for measuring the Q value of superconducting resonant circuits. Minimizing of loss mechanisms, particularly dielectric and coupling losses, is also discussed as is the improvement in Q values as circuits become superconducting. (D.C.W.)

12538 DESCRIPTION OF A DEVICE FOR THE MEASUREMENT OF WALL TEMPERATURE USING THERMOCOUPLES, WITH A VERY GOOD ACCURACY. N. Adorni and A. Parmeggiani (CISE, Milan). Energia Nucl. (Milan), 10: 34-8(Jan. 1963). (In Italian)

The wall temperature of a tube was measured with thermocouples located in a device electrically insulated from the tube itself. The device gave the wall temperature with good accuracy during tests, performed in the range of 250 to 300°C. The accuracy reached was ±0.1°C. (auth)

12539 A SUPERCONDUCTING SOLENOID. G. W. Wilson, G. M. Michie, and D. C. Roberts (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng.). Nature, 196: 1306(Dec. 29, 1962).

Characteristics of a superconducting solenoid wound from 100 ft of Nb-Zr alloy are given. Maximum current required to drive the wire is 23 amp, corresponding to a critical current density in the superconductor of 4.5×10^4 amp/cm^2 and a maximum magnetic field at the solenoid center of 8.8 kgauss. (D.C.W.)

12540 FILTER APPARATUS FOR STUDYING THE SUN'S SHORT-WAVE EMISSION. A. I. Efremov, A. L. Podmoshenskii, M. A. Ivanov, V. N. Nikiforov, and O. N. Efimov. Planetary Space Sci., 9: 987-92(Dec. 1962).

The apparatus described was developed for use in an artificial earth satellite. The basis of the method was separation of the different spectral regions of solar short-wave radiation by a choice of filters that moved automatically to succeed one another in front of a single receiver. Each filter isolated a different spectral region. (C.E.S.)

12541 MONOPOLE SPECTROMETER, A NEW ELECTRIC FIELD MASS SPECTROMETER. Ulf von Zahn (Univ. of Minnesota, Minneapolis). Rev. Sci. Instr., 34: 1-4(Jan. 1963).

The monopole spectrometer uses a r-f electric field between a two-electrode configuration for analyzing ions of different e/m. One electrode has a right-angle cross section, and the other has a circular cross section whose center is located on the bisector of the right angle. The properties of the spectrometer are derived from an approximate equation for the ion motion. An instrument is described that achieves a sensitivity of 0.3 ma/mm Hg at $m/\Delta m$ = 190 with good peak shape, using an analyzing field of 27-cm length. (auth)

12542 HIGH INTENSITY ELECTRODELESS SOURCES FOR RAMAN SPECTROSCOPY. F. X. Powell, O. Fletcher, and E. R. Lippincott (Univ. of Maryland, College Park). Rev. Sci. Instr., 34: 36-40(Jan. 1963).

The construction and performance of high intensity electrodeless arcs powered by a 3-kw r-f oscillator, operating at about 5 Mc, are described. The inherent light intensity realized is as great as in any system that uses electrodes. These sources can be used with mercury, cadmium, thallium, helium, potassium, rubidium, and cesium. Any substance that exhibits or is at a pressure near 10^{-3} torr can be converted to a plasma by the technique described. The effectiveness of these arcs for use in Raman spectroscopy is illustrated. (auth)

12543 SEMIAUTOMATIC SINGLE CRYSTAL ORIENTER. J. W. Kelly (Atomic Energy Commission, Lucas Heights, Australia). Rev. Sci. Instr., 34: 41-4(Jan. 1963).

A semiautomatic method is described that enables the orientation of metal single crystals to be rapidly determined within ±1°; it is a scanning method and requires a three-circle goniometer with automatic drives on two circles at right angles to each other, and a fast acting recorder. A further use of the instrument for the study of the perfection of metal single crystals is also demonstrated. (auth)

12544 He^-, H_2^-, AND OTHER NEGATIVE ION BEAMS AVAILABLE FROM A DUOPLASMATRON ION SOURCE WITH GAS CHARGE EXCHANGE. E. B. Carter and R. H. Davis (Florida State Univ., Tallahassee). Rev. Sci. Instr., 34: 93-6(Jan. 1963).

Negative helium-ion beams are produced in a commercial negative-ion source in which positively charged beams from a duoplasmatron ion source are converted in a gas charge exchange canal. Beams of negative helium ions with currents up to 30 mμa are injected into a tandem Van de Graaff accelerator, and α-particle beams are obtained from the accelerator with energies up to 19 Mev and currents up to 20 mμa. The results of several experiments performed to determine the source operating characteristics for negative helium ions are presented. In addition to the peak corresponding to the He^- beam, many other peaks are observed in the momentum distribution of the beam from the negative ion source. Confirming evidence is found for the existence of the H_2^- ion. (auth)

12545 GONIOMETER-MOUNTED EVACUATED FURNACE FOR SINGLE CRYSTAL NEUTRON DIFFRACTOMETRY. S. C. Abrahams (Bell Telephone Labs., Murray Hill, N. J.). Rev. Sci. Instr., 34: 113-14(Jan. 1963).

A furnace is described that is composed of the "null-matrix" Ti–Zr alloy. This alloy is reasonably transparent to thermal neutrons and is mechanically rigid. The furnace can be evacuated and is electrically heated. It can be mounted on a goniometer when in use. (T.F.H.)

12546 HIGH-CURRENT OPERATION OF RCA TYPE 2059 PHOTOMULTIPLIER TUBES. D. R. Lasher and D. L. Redhead (Univ. of California, Livermore). Rev. Sci. Instr., 34: 115-16(Jan. 1963). (UCRL-6964)

The dynode and photocathode voltages of a group of 5-dynode photomultiplier tubes are adjusted individually, in

order to make the output current a linear function of the incident light intensity at the cathode. The average values of the dynode and cathode voltages that give the optimal linearity in the characteristics are shown. (T.F.H.)

12547 RELAXATION OSCILLATOR. Roy Hayes (to United Kingdom Atomic Energy Authority). British Patent 916,994. Jan. 30, 1963. Filed Jan. 14, 1960.

A relaxation oscillator was described, having a high degree of reliability and capable of oscillating at a very low frequency. Frequencies of one cycle per minute were obtainable. The power output could be larger depending on component ratings. A transductor was provided with windings so connected to cause it to have periodic output. (C.E.S.)

12548 IMPROVEMENTS IN OR RELATING TO ELECTRICAL CIRCUITS PERFORMING A SWITCHING FUNCTION. John Keith Beadsmore (to United Kingdom Atomic Energy Authority). British Patent 917,839. Feb. 6, 1963. Filed Nov. 13, 1958.

An electrical switching circuit is designed for operation at high speeds. The circuit comprises a row of pairs of signal input terminals, a single pair of signal output terminals, a coupling line common to one input terminal leading to one output terminal, a control line between each second input terminal and the second output terminal, a diode between each second input terminal and its associated control line, and a multi-electrode valve to render conducting each diode in sequence. The circuit has one application in temperature measurements from a large number of thermocouple points in a reactor. (D.L.C.)

12549 MULTIVIBRATOR TEST PROBE. Gerald Ambler Watson (to United Kingdom Atomic Energy Authority). British Patent 918,061. Feb. 13, 1963. Filed Nov. 18, 1960.

A small portable signal generator was described for use in testing faulty radio apparatus by injecting a signal into various successive stages until the faulty stage is found. (C.E.S.)

12550 IMPROVEMENTS IN OR RELATING TO METHODS OF MEASURING TEMPERATURES. (to Philips Electrical Industries Ltd.). British Patent 918,564. Feb. 13, 1963. Priority date Apr. 25, 1960, United States.

A method is outlined for measuring the temperature of a medium, particularly at low temperatures. The method comprises introducing uncharged particles, preferably neutrons, into the medium and measuring the energy of the particles which have reached thermal equilibrium with the medium. The variables influencing the method are discussed. (D.L.C.)

12551 HIGH TEMPERATURE THERMOCOUPLE. A. M. Eshayu (to U. S. Atomic Energy Commission). U. S. Patent 3,077,505. Feb. 12, 1963.

This invention contemplates a high temperature thermocouple for use in an inert or a reducing atmosphere. The thermocouple limbs are made of rhenium and graphite and these limbs are connected at their hot ends in compressed removable contact. The rhenium and graphite are of high purity and are substantially stable and free from diffusion into each other even without shielding. Also, the graphite may be thick enough to support the thermocouple in a gas stream. (AEC)

12552 CONTINUOUS ANALYZER UTILIZING BOILING POINT DETERMINATION. W. S. Pappas (to U. S. Atomic Energy Commission). U. S. Patent 3,081,619. Mar. 19, 1963.

A device is designed for continuously determining the boiling point of a mixture of liquids. The device comprises a distillation chamber for boiling a liquid; outlet conduit means for maintaining the liquid contents of said chamber at a constant level; a reflux condenser mounted above said distillation chamber; means for continuously introducing an incoming liquid sample into said reflux condenser and into intimate contact with vapors refluxing within said condenser; and means for measuring the temperature of the liquid flowing through said distillation chamber. (AEC)

Radiation Detection

Refer also to abstract 13063.

12553 (BNL-746) SPARK-CHAMBER LABELING OF TRACKS IN A BUBBLE CHAMBER. J. Fischer and G. T. Zorn (Brookhaven National Lab., Upton, N. Y.). July 1962. Contract [AT(30-2)-Gen-16]. 17p. (BNL-T-272)

Supersedes BNL-6242.

A method of studying the interaction of high energy particles of particular masses in a bubble chamber when exposed in an unseparated beam was devised and experimentally tested. It is based on the labeling of bubble-chamber tracks with the aid of a spark chamber controlled by a particle-selecting counter telescope. By correlating the positions in the spark chamber with those in the bubble chamber, the tracks of the selected particles may be indicated, which permits study of the interaction of these particles in the bubble chamber or their exclusion as an undesired contaminant of the beam. Several particles may be labeled in each bubble-chamber photograph. A preliminary experiment for labeling 5-Bev/c K^- tracks in the 20-in. BNL hydrogen bubble chamber is described. The accuracy with which the track position in the bubble chamber was determined was $\approx \pm 3$ to 4 mm in this case; however, it can be improved to $\approx \pm 1$ mm. Methods used in correlating spark position with bubble-chamber track position are presented, and means of improving the precision and the efficiency of scanning and analysis are discussed. The technique may be applied in beams at momenta up to ≈ 200 Bev/c, as it is limited only by the particle-selecting counter system. (auth)

12554 (CEA-2206) DOSIMETRIE DES NEUTRONS ET IRRADIATION DES SOLIDES. (Neutron Dosimetry and Irradiation of Solids). G. Perriot and A. P. Schmitt (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 154p.

Results of work at C.E.A. from 1958 to 1960 are reviewed. The possibilities offered by classical dosimetry methods are discussed. The tests which led to the utilization, for fast neutron dosimetry, of resistivity variations induced in solid W by such neutrons are described. Experimental W irradiation results led to a definition of neutron efficacity which describes the relations between neutron energy and their effects on materials. Possibilities offered by detectors which make use of radiation damage and are sensitive to neutrons at kev energies were explored. In other work, the principal French reactors were classified according to their ability to produce damage in materials such as W. (J.R.D.)

12555 (JINR-P-1144) OPREDELENIE ENERGII γ-KVANTOV V KSENONOVOI PUZYR'KOVOI KAMERE V DRAPAZONE OT 20 DO 1000 Mev. (Determination of γ-Quantum Energy in a Xenon Bubble Chamber at 20-1000 Mev). Ya. Danysh, Z. Strugal'skiĭ, and O. Chizhevskiĭ (Joint Inst. for Nuclear Research, Dubna. Lab. of High Energy). 1962. 7p.

A simple, quick method is proposed for measuring γ-

quantum energies in a xenon bubble chamber at 20–1000 Mev. (auth)

12556 (TID-15940) A PORTABLE FAST NEUTRON MONITOR FOR DETERMINING URANIUM DEPOSIT WEIGHTS IN CLOSED EQUIPMENT. R. H. Stevens and R. W. Schede (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1962]. Contract [W-7405-eng-48]. 12p.

A monitor for measuring the weights of uranium fluoride compound deposits in process equipment was developed which measures the neutrons resulting from the collision of uranium alpha particles and fluorine atoms. The variables affecting the operation of the monitor are discussed. The accuracy of the monitor is ±25 to 10%. (D.L.C.)

12557 COINCIDENCE CIRCUIT. Bailey L. Donnally (Lake Forest Coll., Ill.). Am. J. Phys., 31: 133-4(Feb. 1963).

A coincidence circuit was described that has the advantages of simplicity, compactness, reliability, and economy. It consisted of a diode coincidence circuit and was followed, when necessary, by a diode discriminator. (C.E.S.)

12558 MEASUREMENT OF RADIOACTIVE RADIATION. Juergen Gottschald (Telefunken-Forschungsinstitutes in Ulm/Donau, Ger.). Elektro-Technik, 43, Nov. 1961. 3p. (In German)

Some of the problems in the measurement of radiation and their solutions are described. The types of radiation and radiation detectors are discussed. One-channel pulse-height analyzers, the network part of the electronic equipment, high-voltage generators, analyzers, and integrators are described. (M.C.G.)

12559 NUCLEAR PHYSICS MEASUREMENT APPARATUS. K. Bartneck. Elektro-Welt, No. B4(1961). 5p. (In German)

After a description of the various kinds of radiation, the most common radiation detectors in construction and mode of operation are explained more closely. The most important radiation measuring places were considered individually according to their functional position for the different measuring problems. The nuclear physics measuring instruments, which are used chiefly for work with isotopes, are the ones considered. Impulse, scintillation, and proportional counters and ionization chambers are described. (tr-auth)

12560 TRANSISTORIZED POCKET TYPE RADIATION MONITOR. H. Klessmann (Hahn-Meitner-Institut für Kernforschung, Berlin). Elektron. Rundschau, 16: 405-7(1962). (In German)

A description is given of the application, properties, circuit, and constructional details of a battery-operated personal warning set that can be constantly carried without inconvenience because of its low weight and small size (pocket dosimeter). No operation of controls is required. The radiation inciding in a miniature Geiger tube becomes audible as a short 3-kc tone; the reception frequency is proportional to the intensity of gamma radiation. When the dose intensity reaches 50 mr/hr, the single acoustical pulses become a continuous sound. A high-efficiency d-c converter and a monostable flip-flop working into matched pairs of transistors result in extremely low current drain of about 0.8 ma so that the battery will last for 1 to 2 months continuous operation with null effect. (auth)

12561 B_4C DEPOSITS FOR ELECTRODES OF IONIZATION CHAMBERS. V. Sangiust, M. Terrani, and S. Terrani (CESNEF, Milan). Energia Nucl. (Milan), 10: 26-8 (Jan. 1963). (In Italian)

A technique of preparing boron-coated electrodes is described. Neutrons and γ sensitivity of an ionization chamber made with these electrodes is reported. (auth)

12562 PARTICLE DETECTORS. PART 3. F. M. Russell. Instr. Pract., 17: No. 1, 43-6(Jan. 1963).

Various instruments are described for the detection and tracking of incident particles. Surface-multiplication instruments described are: photomultiplier tube, scintillation detectors, and Cerenkov detectors; triggered mechanisms are: cloud chambers, bubble chambers, photographic emulsions, and spark chambers. (C.E.S.)

12563 INTERPRETATION OF SATELLITE DETECTOR COUNTER RATES. A. G. Petschek (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 68: 663-5 (Feb. 1, 1963). (LADC-5496)

The efficiency of the shielded Geiger counter in Injun is computed semiempirically to be about 2×10^{-4}. This figure is found to be in reasonable agreement with experiment. (auth)

12564 NUCLEAR RADIATION DETECTORS. G. A. Morton (RCA Labs., Princeton, N. J.). Proc. I.R.E. (Inst. Radio Engrs.), 50: 1266-75(May 1962).

Nuclear radiation detectors are required in all the major fields of nuclear science and technology. They fall into two principal categories, single element detectors and imaging detectors. Single element detectors can be classified into four types, based upon their physical mode of operation. These are (1) scintillation counters, (2) gas ionization detectors, (a) ionization chambers, (b) proportional counters, (c) Geiger-Mueller counters, (3) semiconductor detectors, and (4) chemical detectors. The limitations of these detectors are discussed in terms of sensitivity, energy resolution, speed, and ability to discriminate against background radiations. This gives some indication of the directions along which future developments must proceed. Imaging detectors include both area imaging, such as radioautography and scintillation counter scanning, and track imaging. The various techniques of track imaging from the Wilson cloud chamber and bubble chamber through scintillation track imaging and spark chambers are discussed. (auth)

12565 CHECKING WATER SUPPLIES AND SEWAGE EFFLUENTS FOR RADIOACTIVITY. Public Works, 93: 117-18(Oct. 1962).

Data are given on the application and performance of a new proprietary device for the detection, differentiation, measurement, and recording of radioactivity in a liquid stream. (P.C.H.)

12566 VERSATILE ELECTROMETERS MEASURE LOW LEVEL RADIOACTIVITY. Joe O. Ledbetter (Univ. of Texas, Austin). Public Works, 93: 87-90(Nov. 1962).

Vibrating condenser electrometers for measuring low-level radioactivity in water and their advantages over proportional counters are discussed. (P.C.H.)

12567 THE EFFECT OF DRYING OF NUCLEAR FILMS ON THE VISUAL RANGE OF α PARTICLES. D. Anghelescu and A. Fogel (Polytechnic Inst., Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 7: 149-51(1962). (In Russian)

Following up previously reported observations that treatment of nuclear emulsions with alcohol and other hydrophylic liquids for the purpose of facilitating their drying resulted in the lengthening of the horizontal projection of tracks (L. Vigneron et al., J. Phys. Rad., 16: 179(1955)). A 200-micron thick film was immersed in a $Th(NO_3)_4$ solution for 30 min then into alcohol for a few minutes and developed within 48 hours. The results confirmed the previous

authors' findings concerning the formation of a spongy, porous structure within the emulsion and the lack of effect of the treatment on the vertical dimensions of the tracks; alternating relatively large blackened areas and less than 1-micron wide clear areas were observed. The phenomenon was not generalized: only about 5% of the examined stars exhibited this lengthening of the tracks. In view of the evaporation rate of the alcohol, the phenomenon is limited in time. (TTT)

12568 AN EXPERIMENTAL ASSEMBLY FOR MEASURING THE $\beta-\gamma$ CORRELATION BY MEANS OF CIRCULAR POLARIZATION. T. Bediche, A. Helberg, V. Grabari, P. Kemény, and A. Tripa (Inst. for Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 7: 165-75(1962). (In Russian)

In studying the parity conservation in weak interactions, Lee and Yang (Phys. Rev., 104: 254-8(1956)) demonstrated the nonconservation of the Hamiltonian of the β decay with respect to spatial reflection. In order to study this problem, a universal apparatus was built for determining the angular correlations in circular polarization measurements. The instrument was designed in particular for measuring the forward scattering of γ radiation in the broad energy range from 0.1 to 1.5 Mev. The system consisted of an Armco iron toroid, a stylbene crystal for use as β scintillator, an NaI(Tl) crystal as γ scintillator, Al and Pb shields, radioactive source, magnetic analyzer, coils, and a fast coincidence counter with a photomultiplier; high-voltage stabilizers serve for the current input. The measurements carried out with the apparatus included determination of accidental coincidences, γ-γ coincidences and γ-induced coincidences arising from scattering on other portions of the apparatus. The circular polarization of the γ lines emitted during the β decay of Au^{198} were determined by means of this apparatus. (TTT)

12569 SPARK CHAMBER PERFORMANCE IN HIGH INTENSITY PULSED MAGNETIC FIELDS. Edward D. Platner and J. R. Orr (Univ. of Washington, Seattle). Rev. Sci. Instr., 34: 33-5(Jan. 1963).

Performance of a 9-plate $\frac{1}{8}$-in.-gap stainless-steel-foil spark chamber was tested in close proximity to a 200-kG pulsed magnetic field. No detrimental effect on efficiency was observed for axial field intensity variation of 20 to 100 kG. (auth)

12570 QUEST: AN ON-LINE EVENT-PROCESSING ROUTINE. Margaret H. Alston, James E. Braley, and Peter White (Univ. of California, Berkeley). Rev. Sci. Instr., 34: 64-9(Jan. 1963). (UCRL-10401)

An on-line computing system called QUEST can be used by a physicist to analyze unusual bubble-chamber events. The production version of a program called PACKAGE is modified so that the progress of a single event can be controlled through the subroutines of PACKAGE. Feedback from the computer to the operator permits him to decide what hypothesis he should try next, depending upon the results already obtained. Because the physicist requires time to think what to do next, the QUEST system is designed to be able to interrupt and restore other programs. (auth)

12571 FULL CIRCLE GONIOSTAT FOR DIFFRACTION INTENSITY DATA. M. H. Mueller, L. Heaton, and S. S. Sidhu (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 74-6(Jan. 1963). (ANL-FGF-380)

A full circle goniostat is described for obtaining three-dimensional diffraction intensity data. This instrument permits a complete 360° motion in both ϕ and χ and a limited manual ω adjustment. Electronic angle setting and readout are provided, which facilitate automatic collection of intensity data. (auth)

12572 BUBBLE CHAMBERS FILLED WITH THE MIXTURE IODIDE OF METHYL PROPANE. D. Nyagu and R. G. Salukvadze. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 183-95(1962). (In Russian)

Experiments using the mixture $CH_3I + C_3H_8$ as the working liquid in a bubble chamber are described. Operating conditions and the results of measurements of some physical quantities characterizing the system used are established. Some general considerations concerning the selection of operating conditions are given for bubble chambers filled with two component systems. (auth)

12573 FOTOUMNOZHITELI V STSINTILLYATSIONNYKH SCHETCHIKAKH. (Photomultiplier Tubes in Scintillation Counters). V. V. Matveev and A. D. Sokolov. Moscow, Gosatomizdat, 1962. 160p.

A survey was made of the construction, electronic scheme, and applications of photomultiplier tubes. The parameters, spectral and integral sensitivity, resolving power, and the effects of temperature, electromagnetic fields, and nuclear radiation are analyzed. (R.V.J.)

12574 IMPROVEMENTS IN OR RELATING TO FISSION PRODUCT DETECTION APPARATUS. Kenneth John Williams (to United Kingdom Atomic Energy Authority). British Patent 915,981. Jan. 16, 1963. Filed Aug. 11, 1960.

A fission product detecting apparatus was described that was comprised of a precipitation chamber, radiation detecting means arranged external to each end of the chamber, a collecting electrode through the ends of the chamber, and a means for changing positions of the electrode so that the two portions of the electrode were alternately within the chamber and presented to the radiation detection means. (C.E.S.)

12575 IMPROVEMENTS IN OR RELATING TO NEUTRON FLOW DETECTORS. Maurice Bernard and Lydie Koch (to Commissariat a l'Energie Atomique). British Patent 916,770. Jan. 30, 1963. Priority date Mar. 4, 1958, France,

A new type crystal detector was used in detecting neutron flows. An impurity was diffused throughout a semiconductor crystal of germanium or silicon. The impurity had an atomic radius such that it would penetrate the lattice of the germanium or silicon crystal and give rise to a (n,α) or (n,p) reaction when subjected to a neutron flux. (C.E.S.)

12576 RADIATION WARNING SYSTEM. Ernst Alfred Frommhold (to Veb Vakutronik). British Patent 917,195. Jan. 30, 1963. Filed Jan. 6, 1960.

A radiation warning system was described in which the radiation detection means could be located remote from a radiation measuring means. An ionization chamber was adapted to detect relatively high intensity radiation, and a Geiger-Müller tube was adapted to detect low intensity radiation. Each was effective in operating the same transmitter for pulsed signals representative of the radiation detected. (C.E.S.)

12577 IMPROVEMENTS IN OR RELATING TO METHODS AND APPARATUS FOR CONTINUOUS MEASURING OF CONCENTRATION OF RADIOACTIVE AEROSOLS. (to Telsa, Narodni Podnik). British Patent 917,238. Jan. 30, 1963. Priority date June 1, 1960, Czechoslovakia.

A method was described for the continuous measurement of radioactivity in air. The method consists of concentrating particles on a deposition support in a suitable filter and moving the deposition support gradually from the filter to a monitor for the detection of radiation. (C.E.S.)

ISOTOPE SEPARATION

12578 FUNDAMENTAL STUDIES ON THE ION EXCHANGE SEPARATION OF ISOTOPES. V. SEPARATION FACTOR OF URANIUM ISOTOPES USING ION EXCHANGER. Hidetake Kakihana (Tokyo Inst. of Tech.), Yoshihiro Mori, Hitoshi Sato, and Tadao Kanzaki. Nippon Genshiryoku Gakkaishi, 4: 857-60(Dec. 1962). (In Japanese)

Breakthrough experiments are done through a cation exchange resin column of 100 cm height and 1 cm diameter with 0.6$\underline{N}$ and 2$\underline{N}$ hydrochloric acid solutions containing greater part of uranous ions together with smaller uranyl ions. For each experiment the largest depletion of U^{235} is found at the front of uranous breakthrough, while minor depletion is also observed at the front of uranyl fraction. An equation giving the approximate value for the separation factor S^{235}_{238} from the breakthrough results is derived. Where D is total depletion of U^{235} in eluates, Q is total amount of uranium adsorbed on the column, and R_0 is the mole fraction of U^{235} in the original sample solution. The values 1.00028 ~ 1.00048 are obtained for S^{235}_{238}. (auth)

12579 THEORY AND PERFORMANCE OF THERMAL-DIFFUSION COLUMN. S. C. Saxena and S. Raman (Atomic Energy Establishment, Trombay, India). Revs. Modern Phys., 34: 252-66(Apr. 1962).

The assumptions made in the theory of thermal diffusion columns are noted. A transport-theoretical analysis is made of these assumptions, and it is found that the errors introduced by the assumptions can be corrected for, so that a quantitative theoretical evaluation of the performance of a thermal column can be made. Results are shown for He, Ne, Ar, Kr, O_2, H_2, and CH_4 as examples. (T.F.H.)

MATHEMATICS AND COMPUTERS

Refer also to abstract 12839.

12580 (DP-804) FORTRAN CODES FOR COMPUTING REACTOR FLUX SHAPES IN ONE DIMENSION. William V. Baxter (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1962. Contract AT(07-2)-1. 35p.

Two FORTRAN codes were prepared for the IBM 704 computer to obtain one-dimensional solutions of the steady-state neutron-diffusion equation in a cylindrical reactor. Solutions are obtained in either a radial or an axial direction. The axial solution was used in a rod positioning code designed to approximate the control rod setting which will provide an optimal flux shape. A maximum of six homogeneous regions may be used for the flux solution in either direction. Criticality is achieved by variation of the material buckling in all or in any one of the six regions, or by adjustment of an interface. (auth)

12581 (LAMS-2801) A CODE FOR REDUCING MANY-GROUP CROSS SECTIONS TO FEW GROUPS. Ralph S. Cooper (Los Alamos Scientific Lab., N. Mex.). Dec. 1962. Contract W-7405-eng-36. 53p.

Supersedes LAMS-2747.

A code (ZOT) was written which will produce few-group neutron cross sections from many-group sets based on a given flux spectrum or one computed for an infinite medium. The cross-section format is that of S_n transport theory including the possibility of upscattering in energy. The code is written in the Floco II system for use on the IBM 704 or IBM 7090. (auth)

12582 (RFP-297) COMPUTER PROGRAM TO PERFORM FOURIER ANALYSIS OF X-RAY DATA. C. L. Bell, A. Goodwin, Jr., and G. R. Mallett (Dow Chemical Co. Rocky Flats Plant, Denver). Feb. 4, 1963. Contract AT(29-1)-1106. 22p.

A mathematical outline for the determination of Fourier coefficients for corrections of widths and shapes of lines from x ray diffractograms is presented. The computer program discussed applies to the Bendix G-15D computer. The program can be used to calculate the Fourier coefficients $\overline{U}_r(z)$ and $\overline{U}_i(z)$ for the corrected distribution. (auth)

12583 (WAPD-TM-352) MO322 AND MO332 — FORTRAN PROGRAMS FOR CALCULATING NEUTRON ABSORPTION IN SPHERES DISTRIBUTED RANDOMLY. Interim Memorandum. R. M. Cantwell (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1962. Contract AT(11-1)-Gen-14. 31p.

Programs for one energy, Monte Carlo calculations of the neutron fraction absorbed in spheres distributed randomly, for the case of program MO322 in an otherwise infinite homogeneous medium, while for the case of program MO332, in one region of an otherwise one-dimensional, three region cell. (J.R.D.)

12584 (UCRL-Trans-891(L)) PROOF THAT A MECHANICAL NORMAL SYSTEM IN GENERAL IS QUASI-ERGODIC. ON THE EXISTENCE OF QUASI-ERGODIC SYSTEMS. Enrico Fermi. Translated by Stephen G. Brush (Univ. of California Lawrence Radiation Lab., Livermore) from Physik. Z., 24: 261-5(1923); ibid. 25: 166-7 (1924). 9p.

Also published in Enrico Fermi Collected Papers, Vol. I, p. 79-87, University of Chicago Press, 1962.

Generalization of Poincare's theorem that a canonical normal system in general can not possess any analytical unique time-independent integrals aside from the energy integrals F = const is used in proving that a mechanical normal system is quasi-ergodic. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstracts 12230 and 13731.

12585 (AD-277775) EVALUATION OF PFAUDLER COATING FOR OXIDATION PROTECTION OF COLUMBIUM ALLOYS. Final Report. Report No. 8886. T. C. Grimm (McDonnell Aircraft Corp., St. Louis). Aug. 25, 1961. Contract AF33(657)-7749. 20p.

Portions of the Asset vehicle which attain temperatures above 2500°F will require the use of refractory metals and associated protective coatings. A disilicide coating appears promising for this purpose. Tests show that a two-step disilicide coating provides oxidation protection for Nb alloys for periods of 1 hr at 3100°F. Coated Nb alloy, Nb–1Zr, and F-48 specimens were tested for oxidation resistance at 2800 to 3200°C. Five of these specimens were tested using an oxy-acetylene torch with an excess of O_2, and three were plasma jet tested. The disilicide coating protected the Nb alloys from gross oxidation at 2800 to 3200°F for 15 min test periods. (auth)

12586 (AD-277791) UNPUBLISHED MATERIALS RESEARCH AND DEVELOPMENT PROGRAMS. First Semi-Annual Summary Report. Report No. 8938. (McDonnell Aircraft Corp., St. Louis). July 10, 1962. Contract AF33(657)-7749. 83p.

Fifty current test programs were reviewed, summarized, and index coded for content. The test programs can be categorically grouped as follows: mechanical, physical, chemical, and miscellaneous properties of the light metals, low and ultra high strength steels, austenitic stainless steels, nickel chromium steels, titanium alloys, cobalt base alloys, nickel base alloys, and refractory metals; mechanical, physical, and miscellaneous properties of plastic materials such as acrylics, epoxys, phenolics, polyesters, urethanes and vinyls; effects of plating on the fatigue strength of 4340 steel; chemical and miscellaneous properties of organic finishes, inorganic finishes, surface conditioning treatments and chemical finishes when exposed to a corrosive environment and/or elevated temperature; effects of inorganic finishes on the mechanical, physical, and chemical properties of refractory metals; chemical and miscellaneous properties of lubricants; and mechanical, physical, and chemical properties of nickel and copper electroformed parts. (auth)

12587 (NAA-SR-7736) PULSE HEATING OF MODIFIED ZIRCONIUM–URANIUM HYDRIDES. R. E. Taylor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1963. Contract AT (11-1)-Gen-8. 26p.

Fourteen samples of modified Zr–U hydrides ($ZrU_{0.04}H_{1.8\pm0.1}$) were pulse heated to destruction. Data on power input, electrical resistivity, temperature, and H_2 release during the 450 msec pulses are presented. Half of the samples heated nonuniformly, owing to internal flaws; two failed catastrophically; and five samples heated uniformly. Essentially all of the H_2 was released from three of the latter samples. A phase change was observed at an average composition of $ZrU_{0.04}H_{1.40\pm0.02}$, and the specific heat was represented by $c_p = 0.0898 + 8.44 \times 10^{-5}$ t cal/g-°C at 25 to 850°C. Following the phase change, 49.2 ± 2.0 kcal were required to drive one mole of H_2 from the fuel. (auth)

12588 (NMI-9249) REFRACTORY METALS PHASE DIAGRAMS. Quarterly Progress Report, October 1, 1962 to December 31, 1962. E. J. Rapperport (Nuclear Metals, Inc., Concord, Mass.). Feb. 8, 1963. Contract AF 33(616)-7157. 9p.

Preparation of homogeneous Mo–Ti–Zr alloys is reported. Equilibration of several samples was completed. Eight $ZrMo_2$ + Mo alloys are being prepared with C content of 0.1 and 0.2%. A phase diagram for Mo–Ir was completed during the quarter. A Ta–W–Zr diagram is almost completed and work on Nb–Ru, and W–Pd is in progress. Phase studies on Nb–Rh, Nb–Ir, Mo–Os–W, Nb–Hf, and Hf–Re–W alloys are in progress. (J.R.D.)

12589 (NP-12543) RESEARCH PROGRAM RELATED TO VAPOR THERMIONIC CONVERTERS FOR NUCLEAR APPLICATION. Quarterly Progress Report, September 27–December 27, 1962. A. O. Jensen (Electro-Optical Systems, Inc., Pasadena, Calif.). Jan. 16, 1963. Contract NAS3-2529. 44p. (EOS-3410-Q-1)

Progress in an investigation of long-time temperature effects on the surface structure of polycrystalline Mo substrates is reported. The major effort is being directed toward determining the effects of such changes in the surface crystal structure on the performance of cesiated Mo emitters for use in nuclear powered thermionic converters. The material selected for use in the investigation is high-quality mill stock which is low in C content and interstitial gas impurities. Results of preliminary processing are given along with investigations of grain growth and cesiated emission. Other work is reported on selection of an electron microscope lens configuration, design of a lens support and a method of moving the emitter relative to the lens. (J.R.D.)

12590 (TID-8213) DEVELOPMENT OF DEPLETED-URANIUM CATALYSTS FOR DESTRUCTION OF AIR POLLUTANTS IN AUTOMOBILE EXHAUST. PART I. DEVELOPMENT OF CATALYSTS CONTAINING DEPLETED URANIUM. PART II. OPERATION OF MOBILE-LABORATORY TEST VEHICLE. Report of Research Progress, Fiscal Year 1962. (Bureau of Mines, Washington, D. C.). 48p.

Activities in a program to prepare and test U catalysts for the oxidation of automobile exhausts are reported. The U–Cu–Cr–Al_2O_3 system was investigated to establish the contribution of U to the total activity. A partly poisoned catalyst bed from a vehicle test with leaded gasoline was investigated to determine catalytic activity and crystalline structures present. Urania catalysts prepared from U salts other than nitrate and with solvents other than water were evaluated. Isopentane was chosen for use in the tests because it is one of the more difficultly oxidized hydrocarbons. Results indicate that some of these preparations meet the California Standards for exhaust gas composition when properly used. Four of the tested catalysts, all impregnated with alumina spheres, oxidized isopentane from 0.2% concentrations to below 0.033% at 600°C in the presence of 2% CO and 4% O_2 under average automobile exhaust conditions. Data and information concerning static tests and mobile-laboratory test vehicle operations are included. (J.R.D.)

12591 (TID-17912) AN INVESTIGATION OF THE ELECTRICAL AND OPTICAL PROPERTIES OF SEMICONDUCTORS AND INSULATORS WHICH HAVE BEEN IRRADIATED BY FAST NEUTRONS. Final Report. (Arizona State Univ., Tempe). Jan. 1963. Contract AT(11-1)-715. 29p.

Two sections are included in the report. Separate abstracts were prepared for each section. (J.R.D.)

12592 (TID-17912(p.1-7)) COLLOIDAL PARTICLES IN IONIC CRYSTALS. R. Jensen (Arizona State Univ., Tempe).

Results of investigations concerning colloidal metallic-particle absorption bands of CaF_2, NaF_2, and CsBr ionic crystals are discussed. The absorption bands were observed near the predicted plasma wave lengths and results are compared with theoretical values. The investigation revealed that it is necessary to prove the existence of colloidal particles by an independent method. Further investigation is planned. (J.R.D.)

12593 (TID-17912(p.8-27)) RADIATION DAMAGE IN RUTILE. L. Stubbe (Arizona State Univ., Tempe).

The effects of radiation on the electric conductivity of TiO_2 were investigated. The measurements were made at −70 to 200°C on samples which were exposed to 10^{15} to 10^{18} nvt fast neutrons. Results are discussed and conclusions are presented. (J.R.D.)

12594 (EURAEC-125) REPORT ON THE STATE OF PROGRESS OF THE STUDY OF THE SHAPING AND IRRADIATION OF URANIUM MONOCARBIDE. Quarterly Report No. 2, March 15 to June 15, 1961. B. Mansard and P. Rousset (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). July 13, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 033-60-12 RDF. 24p. A translation.

Methods of preparing UC or other cermets rich in UC are proposed, based on extrusion of graphite-U powder mixtures followed by heat treatment. Results of experiments in which the C content was varied are included. A study of UC hydrolysis revealed that it occurs rapidly but is not explosive in nature. In other work it was found that fission gases are retained by UC sintered under load better than by UO_2. (J.R.D.)

12595 (EURAEC-309) STUDY OF THE COATING OF CERAMIC URANIFEROUS PARTICLES BY MEANS OF METALLIC NIOBIUM. Quarterly Progress Report No. 3, January 1 to March 31, 1962. (Brussels. Société d'Etudes, de Recherches et d'Applications pour l'Industrie; Brussels. Centre d'Etude de l'Energie Nucleaire; and Société Belge pour l'Industrie Nucleaire, Brussels). Apr. 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 066-61-7RDB. 51p. A translation.

About 10 complete coating operations were carried out during the period. Selection of a reactor type is reported in which a regular turbulent fluidization of U in a mixture of H_2 + $NbCl_5$ is achieved without gas injection through capillary tubes. Coating experiments were conducted in which the H_2:$NBCl_5$ ratios were varied. Considerable coating of the walls and particle agglomeration were encountered during these tests. Results show the marked effects of the hydride proportion on the coating properties. Experimental results also show that it is possible to carry out a complete coating operation for 100 g batches of particles within about 10 hrs. (J.R.D.)

12596 REFRACTORY METALS AND THEIR PROTECTION. Thomas D. Cooper and Oscar O. Srp (Aeronautical Systems Div., Wright-Patterson AFB, Ohio). Aerospace Eng., 22: No. 1, 46-55(Jan. 1963).

A brief review is presented of the significant properties of the refractory metals that make them potentially useful materials, the applications for which they appear suited, and the problems that hinder their development, such as their notoriously poor oxidation resistance and their ductile-brittle transition behavior. The mechanical properties of a number of representative alloys are discussed and compared, as are efforts to provide them in useful wrought form. The discussion of protection deals with the development of coatings to prevent the high-temperature oxidation and atmospheric degradation of refractory metals in structural applications. Factors leading to the evolution of current coating approaches, and a description of the coating systems which are the current leading contenders, are presented. Development of coatings for protection of refractory metal alloys above 3,000°F is shown to be in its infancy. (auth)

12597 THE FORMATION OF A ZINC OXIDE–NIOBIUM PENTOXIDE SPINEL. Robert W. Harrison and Eugene J. Delgrosso (United Aircraft Corp., Middletown, Conn.). J. Electrochem. Soc., 110: 205-9(Mar. 1963).

The spinel $7ZnO \cdot Nb_2O_5$ ($Zn_7Nb_2O_{12}$ or $Zn_{2.33}Nb_{0.67}O_4$) was synthesized. The reactions occurring between ZnO and Nb_2O_5 were investigated as a function of temperature and composition. Evidence is presented to demonstrate the important role ZnO vapor played in formation of the spinel. It would appear that in the Nb_2O_5–ZnO system spinel formation was the last stage in a sequence of reactions in which the lowest symmetry oxide structure was formed first and the highest symmetry oxide, the cubic spinel, formed last. This reaction sequence agreed with Goldschmidt's "oxide structure sequence" proposed for the NiO–Nb_2O_5 and MgO–Nb_2O_5 systems. (auth)

12598 PREPARATION OF NEPTUNIUM TARGETS BY ELECTRODEPOSITION. G. A. Dupetit (Comisión Nacional de Energía Atómica, Buenos Aires). J. Inorg. Nucl. Chem., 24: 1297(Dec. 1962).

A method is outlined for the preparation of Np targets by electrolytic deposition of the oxide or hydroxide on metal cathodes. Uniform targets of 0.2 to 4 mg on a Ni cathode area of 7 cm^2 were prepared, and heavier targets of up to 7 mg were also prepared by several successive electrodepositions. (D.L.C.)

12599 THORIUM AND THORIUM–URANIUM ALLOY VACUUM INDUCTION MELTING AND CASTING. N. H. Katz, E. G. Kendall, and M. H. Binstock (Atomics International, Canoga Park, Calif.). Mod. Castings, 42: 80-6 (Nov. 1962).

Refractory oxide-coated graphite was investigated as a crucible material for producing Th–U castings. Oxides of Y, Th, Zr, and Be were applied to graphite crucibles by wash coating and, when possible, by flame spraying. Thorium, as well as alloys of Th-1 to 13 wt. % U, were prepared by vacuum induction casting. The castings were evaluated on the basis of number and intensity of surface and internal defects, homogeneity of composition, and metallurgical properties. Effectiveness of the refractory oxide coating was measured in terms of crucible attack and degree of carbon contamination in the Th–U castings. Best results were obtained with wash coatings of Y_2O_3 and ZrO_2 and a flame sprayed coating of ZrO_2. ThO_2 was found to be unsuitable and BeO requires additional investigation. (auth)

12600 X-RAY MASS ATTENUATION COEFFICIENTS IN THE RANGE OF 50 to 150 KVP. B. E. Foster and J. W. Evans (Oak Ridge National Lab., Tenn.). Nondestructive Testing, 21: 51-8(Jan.-Feb. 1963).

Measurements were made of the x-ray absorption coefficients of specific alloys as a function of energy from 40 to 130 kev. The alloys investigated were types 304 and 347

stainless steel, 1100 aluminum, Zircaloy-2, and enriched U–Al alloys. The experimental results were compared with calculated data; the deviations were found to be small except for the U–Al alloys. (D.L.C.)

12601 COMPARISON OF THE EFFICIENCY OF CHLORINE, NITROGEN, AND CHLORINE–NITROGEN MIXTURES FOR DEGASSING AN ALUMINUM–COPPER–MAGNESIUM ALLOY. G. D. Denyer (Aluminium Labs. Ltd., Banbury, Eng.). Rev. Met. (Paris), 59: 857-62(Oct. 1962). (In French)

Results show that chlorine is clearly more efficient than nitrogen. The magnesium loss during degassing varies with the chlorine content of the mixture and with bath temperature. (auth)

12602 THE ZIRCALOY-2 IN-PILE CREEP MEASUREMENTS AT CHALK RIVER. V. Fidleris (Atomic Energy of Canada Ltd., Chalk River, Ont.). Preprint Paper No. 62-WA-325. New York, The American Society of Mechanical Engineers, 1962. 12p. $1.00.

Paper from Winter Annual Meeting, New York, Nov. 1962.

The difficulties associated with the development of an in-pile creep machine are described. The results of three in-pile creep tests at 300°C on Zircaloy-2 are presented and discussed. At 30,000 psi stress, an increase in creep rate was observed. The results of 20,000-psi tests are inconclusive. (auth)

12603 PURIFICATION OF ZIRCONIUM BY SOLID STATE ELECTROLYSIS AND ZONE REFINING. Thomas Tucker Claudson. Thesis, Corvallis, Ore., Oregon State Univ., 1962. 103p.

The purification of Zr by solid state electrolysis and zone refining was studied. Equipment used in the investigations consisted of a vacuum system capable of operating below 1×10^{-4} mm of Hg with suitable power supplies to zone refine the material by electron bombardment and perform the solid state electrolysis by resistance heating of the specimen from a direct current power source. The results of both zone refining and solid state electrolysis were determined primarily by chemical and metallographic analyses. The analyses showed that in the case of zone refining, metallic impurities of Fe, Ni, Cu, and Al were reduced to 1, 1.8, < 0.05, and 3.3 ppm, respectively. The initial impurity content for Fe, Ni, Cu, and Al was 600, 12, 20, and 90 ppm, respectively. In the case of solid state electrolysis the oxygen migration of the oxygen to the anode end of the rod specimen was found to occur and thus reduced the oxygen content in the central and cathode end of the rod. These regions were reduced of their oxygen content to a minimum of 190 ppm from an initial oxygen content of 1100 ppm. It was also found that a voltage potential of four volts or greater was required to effect the oxygen migration. Calculations of the electrolytic transport number and mobility of oxygen through zirconium indicated the values to be 3.662×10^{-5} gram-atoms per Faraday and 4.47×10^{-5} square centimeters per second volt, respectively. (P.C.H.)

12604 ENVIRONMENTAL FACTORS WHICH INFLUENCE MATERIALS, PROPERTIES, AND NUCLEAR REACTOR DESIGN. C. O. Smith (Oak Ridge National Lab., Tenn.). Preprint No. ASME 61-WA-282. New York, American Society of Mechanical Engineers, 1962. 12p. $1.00.

The ASME Boiler and Pressure Vessel Code provides minimum safety requirements for new construction but does not normally provide specific rules to cover deterioration which may occur in service due to a number of environmental factors. The nuclear cases of the code do say that particular consideration shall be given to these effects with a view to obtaining the desired life of nuclear reactor and associated primary vessels. An examination is made of these environmental factors and the relationships between them in nuclear reactors to provide background information which will assist the designer in giving "particular consideration" to these factors. (auth)

12605 IMPROVEMENTS IN THE MANUFACTURE OF ALLOYS OF REFRACTORY METALS. Ernest Samuel Nossen and Roy Earl Parks (to Alscope Explorations Ltd.). British Patent 915,693. Jan. 16, 1963. Filed Dec. 8, 1959.

A process was provided for the preparation of alloys of refractory metals, together with major amounts of nonrefractory metals, which may be carried out well below the melting point of the refractory metals to be incorporated. The losses of metallic constituents were held to a minimum. Refractory metals were supplied in the form of relatively inexpensive and readily available starting materials. The process was carried out in a simple manner and without requiring expensive apparatus and resulted in alloys of excellent quality at high yields. The process lends itself to continuous operation and to the reclamation and reuse of auxiliary materials and by-products. (C.E.S.)

12606 PROCESSES FOR THE PRODUCTION OF FERRO-CHROME ALLOYS OF LOW COBALT CONTENT. (to Avesta Jernverks Aktiebolag). British Patent 918,237. Feb. 13, 1963. Priority date Apr. 10, 1958, Sweden.

A process is given for reducing the Co content of a molten Cr ore in order to produce a stainless steel with low Co content for use in the nuclear industry. The process comprises selectively reducing the Co of the molten ore after adding powdered Cr/Ni to increase the phase contact surface. The reducing agent may be C, C compounds, Si, Al, Ca, or Ti. (D.L.C.)

12607 REUSABLE REACTION VESSEL. Tylor S. Soine (to U. S. Atomic Energy Commission). U. S. Patent 3,079,136. Feb. 26, 1963.

This patent shows a reusable reaction vessel for such high temperature reactions as the reduction of actinide metal chlorides by calcium metal. The vessel consists of an outer metal shell, an inner container of refractory material such as sintered magnesia, and between these, a bed of loose refractory material impregnated with thermally conductive inorganic salts. (AEC)

12608 DOUBLE-BAKED, SELF-CHANNELLING ELECTRODE. Roger D. Piper and Robert F. Leifield (to U. S. Atomic Energy Commission). U. S. Patent 3,081,237. Mar. 12, 1963.

A method is given for making an electrode for use in the electrolytic reduction of uranium oxides to uranium metal in a fused salt electrolyte. Uranium oxide such as UO_2 is mixed with somewhat less than the stoichiometric amount of carbon needed for the reduction, and the mixture is baked and crushed to make a nonspherical material. The latter is then mixed with a carbon binder sufficient to satisfy stoichiometry, pressed into a shape such as a cylinder, and baked. (AEC)

Corrosion

Refer also to abstract 12064.

12609 (ANL-FGF-402) THE OXIDATION OF ZIRCONIUM BINARY ALLOYS IN 700°C OXYGEN FOR TIMES UP

TO 200 DAYS. R. D. Misch and C. Van Drunen (Argonne National Lab., Ill.). Oct. 30, 1962. Contract [W-31-109-eng-38]. 39p. (UAC-7067)

The cubic rate law of oxidation followed by transition was studied for a series of Zr binary alloys using relatively long times. Transition may occur rapidly or slowly depending upon the alloy. In the case of rapid transition the cubic slope goes directly to a linear slope. Thus, there is no basis for applying Smeltzer's mechanism where the cubic law is regarded as a transitory condition prior to establishment of a parabolic law. In the case of slow transition a parabolic region may occur but probably does not represent a stable condition. A new theory is proposed for the cubic rate law based on the assumption that the migration processes contributing to oxide growth have an inverse dependence on the compressive stresses in the oxide. For the simplest case where the compressive stresses increase linearly as the oxide thickens the growth rate will diminish as $1/x^2$ instead of $1/x$, where x is the oxide thickness. This theory can account for many of the anomalous features of Zr oxidation. (auth)

12610 (ARF-B6001-2) HIGH-TEMPERATURE OXIDATION PROTECTIVE COATINGS FOR VANADIUM-BASE ALLOYS. Bimonthly Report No. 2, November 13, 1962–January 12, 1963. John J. Rausch and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 9, 1963. Contract N600(19)59182. 13p.

Processing variables relating to the pack-siliconizing of V-5 wt % Ti-20 wt % Nb and V-1 wt % Ti-60 wt % Nb are being studied. Samples coated at 2010, 2190, and 2370°F show that coating growth rate is time dependent up to 16 hours. Silicide coatings have been applied to 11 vanadium alloys currently under development, and no failures have been observed after 15 to 35 hours in 2200°F air. Tensile and other specimens of V-1 wt % Ti-60 wt % Nb have been pack-siliconized for evaluation by aerospace and other organizations. Compounds of V-Nb-Ni were flame-sprayed on V-1 wt % Ti-60 wt % Nb, but excessive porosity caused rapid failure in 2000 and 2200°F air. Diffusion couples of nickel and the V-Nb-Ti alloy were reacted at 2000 and 2200°C for 24 and 8 hours, respectively, with very slight hardening of the vanadium alloy. (auth)

12611 (TID-17861) SPECIFICATION FOR STAINLESS STEEL CORROSION RESISTANT CASTINGS FOR VERY AGGRESSIVE SERVICE. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 29, 1962. Contract [W-31-109-eng-52]. 6p. (HWS-7444)

A specification covering castings of corrosion-resistant steel of 24 chrome-13 nickel grade for use in very aggressive corrosive service is presented. (H.G.G.)

12612 OXIDATION BEHAVIOR OF TITANIUM, NIOBIUM, AND THEIR ALLOYS. M. K. McQuillan. Corrosion Anti-Corrosion, 10: 361-78(Nov. 1962). (In French)

The mechanisms of high-temperature oxidation in niobium, titanium, and their alloys are discussed from the viewpoint of the laws that control the oxidation velocity and implied processes. After a consideration of the factors that affect the oxidation processes (oxygen solubility and diffusion in the metal and in the oxide film), the effect of the addition of an alloying element on these factors and the direct effect of the alloying elements on the oxidation velocities are studied. The practical problems are discussed in the light of experimental results obtained on complex alloys of niobium. (tr-auth)

12613 USE OF CHEMICAL NICKEL PLATING OF PEARLITIC STEEL OBJECTS IN THE CONSTRUCTION OF TURBINES USED FOR THE GENERATION OF ENERGY. A. V. Ryabchenkov, V. I. Velemitsyna, and L. D. Zamoshnikov (Central Scientific Research Inst. for Machine Construction, USSR). Metalloved. i Term. Obrabotka Metal., No. 12, 30-3(Dec. 1962). (In Russian)

Portions of energy-generating machinery which must operate at temperatures of 565 to 585°C, in gaseous media, such as superheated steam or air, are subject to excessive wear and tear as the result of their low corrosion and erosion resistance. Extended exposure to these temperatures may cause a diffusion of nitride layers with subsequent loss of antifriction properties. It was found possible to protect the metallic surfaces by depositing a Ni coating from a Ni hypophosphate solution. The temperature of application is only 88 to 90°C at a pH of 4.8 to 5.3. This non-electric method yields a uniform Ni–P layer even on complex surfaces. The coating has a high hardness of 850 to 900 kg/mm^2, good adherence to the base steel, high corrosion resistance against superheated steam, and excellent thermal shock resistance. The method is recommended for protecting pearlitic steel components of steam turbines operating at 140 to 240 atm. and at temperatures up to 585°C. (TTT)

12614 CORROSION PROBLEMS IN ATOMIC ENERGY REACTORS—AN ORIENTATION. Bjoern Forsén (AB Atomenergi, Stockholm). TVF (Tek.-Vetenskaplig Forskning), 33: 279-82(1962). (In Swedish)

The corrosion problems in reactors–water-cooled, pressurized-water, boiling, and superheated boiling reactors–are discussed. (tr-auth)

12615 CORROSION OF REACTOR MATERIALS. VOL. II. Proceedings of the Conference Held at Salzburg, Austria, 4-8 June 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Sept. 1962. 598p. (STI/PUB/59(Vol. II)). $11.00; 231s; NF 44; DM 38.50(IAEA).

A total of twenty-six papers were presented at the Conference. Separate abstracts were prepared for nine of the papers. Seventeen of the papers were previously abstracted in NSA. (J.R.D.)

12616 THE BEHAVIOR OF ALLOY STEEL IN BICARBONATE SOLUTIONS, THE EFFECT OF CHLORINE AND OXIDANTS. L. Klimczak-Mathieu, J. Meunier, M. Pourbaix, and C. Vanleugenhaghe. p.1-49 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In French)

Corrosion of 18/8 Cr–Ni alloy steels and Cr steel by 0.10 M sodium bicarbonate solution containing varying quantities of NaCl was studied. It was found that corrosion under these conditions can be evaluated in terms of breakthrough potentials that can be determined by variable potential methods or chemical means. A critical chloride content was found below which no corrosion occurs at potentials below those required for water decomposition. (J.R.D.)

12617 CORROSION AND EROSION OF FERRITIC STEELS BY LIQUID BISMUTH. Y. Imai, T. Ishizaki, K. Nishino, and T. Masumoto (Tohoku Univ., Sendai). p.51-65 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

Experiments are described in which specimens of Fe–C systems and Fe–Cr alloys were immersed in static liquid Bi under an Ar atmosphere at 600 to 950°C. Mg and Zr were added to the Bi as inhibitors. Corrosion in the Fe–C specimens was less in the range over 0.2% C. Corrosion in the Fe–Cr alloys increased with the increase of Cr content, but was reduced by increase of C. Iron-base

cavitation erosion by Bi was also investigated using an ultrasonic oscillator of 20 ± 2 kc. It was found that the principal factor controlling the attack is hardness rather than the alloy composition. (J.R.D.)

12618 RESEARCH ON THE CORROSION OF ZIRCONIUM ALLOYS IN WATER AND STEAM AT HIGH TEMPERATURE AND PRESSURE. A. A. Kiselev, V. A. Myshkin, A. V. Kozhevnikov, S. I. Korolev, and E. G. Shorina. p.67-104 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Data obtained in research on the corrosion of Zr–Nb alloys by steam and water at high temperatures and pressures are reported. The corrosion process of Zr–1% Nb alloy was found to involve a thick oxide film formed in the first hours of exposure after which the corrosion rate drops rapidly. Data are also given on changes in the mechanical properties during corrosion tests up to 18000 hr. In other investigations it was found that Zr alloys with 0.25 to 1.5 wt. % Nb and small quantities of Fe are stable and resistant to H_2 absorption. (J.R.D.)

12619 THE CORROSION OF ZIRCONIUM ALLOYS. J. Boulton (Reactor Materials Lab., Warrington, Eng.). p.133-47 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

The corrosion of Zr-base alloys in steam at 800 lb/in^2 and 280 to 400°C and at 15 lb/in^2 at 400 and 500°C was studied. Results are presented for Zircaloy-2, low Ni–Zircaloy-2, Zircaloy-3, Zr–2½% Nb, Zr–½% Cu, Zr–½% Cu–½% Mo, Zr–1% Cu–1½% Mo, and Zr–½% Cu–½% W. These show that the Zircaloy-type alloys and Zr–2½% Nb, although slightly inferior, have good corrosion resistance at the lower temperatures, but the resistance deteriorates as the temperature increases. Although the Cu-containing alloys have promising corrosion resistance to steam at 500°C at atmospheric pressure, the corrosion resistance deteriorates as the temperature is decreased and as the pressure is increased. Results of H_2 analyses of samples of Zircaloy-type alloys and Zr–2½% Nb alloy exposed in these tests show that there is little or no difference in the H_2 pick-up of Zircaloy-2 and Zircaloy-4 at equivalent weight gains; these alloys pick up a greater percentage of the corrosion H_2 produced in the post-transition region than of that in the pre-transition region—in the post-transition region this amounts to some 50% of that theoretically produced; and the Zr–2½% Nb alloy picks up approximately 10% of the corrosion hydrogen in both the pre- and post-transition regions. (auth)

12620 CORROSION RESISTANCE IN A STEAM–WATER MEDIUM AND MECHANICAL PROPERTIES OF HAFNIUM WITH A HIGH ZIRCONIUM CONTENT. R. V. Grebennikov and F. P. Shamashov. p.149-58 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Results of comparative studies of the mechanical properties and corrosion resistance of Hf containing 3 to 50% Zr are presented. Hf containing up to 30% Zr has a high corrosion resistance in water at 350°C. The mechanical properties of Hf are reduced slightly when the Zr content is increased from 3 to 25%. The prolonged action of a steam–water medium at 350 to 400°C does not lead to any noticeable deterioration in the mechanical properties of Hf containing 3% Zr. (auth)

12621 THE EFFECTS OF IRRADIATION ON THE OXIDATION OF ZIRCONIUM ALLOYS. R. C. Asher and B. Cox (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.209-21 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

Results are presented on the effects of reactor irradiation on the oxidation of Zircaloy-2, Zr–2½% Nb, and Zr–½% Cu–½% W alloys in steam. Gamma radiation produces a small increase in the rate of growth of thin (interference color) oxide films on Zircaloy-2 at temperatures below 400°C. This effect may be neglected for the thicker oxide films of interest in reactor technology. High fluxes of fast neutrons ($>10^{13} n_f v$) have a significant effect in both the pre-transition and post-transition regions of oxide film growth. For irradiation of Zircaloy-2 in steam at 340°C, 1 atm pressure, a flux of 3×10^{13} $n_f v$ (> 1 Mev) decreases the time to transition and also increases the post-transition rate of oxidation; the factor for both is about eight. The magnitude of this effect of fast neutrons is dependent upon the temperature of exposure, neutron fluxes as low as 10^{11} $n_f v$ being able to produce substantial effects at temperatures between 400 and 600°C (with a maximum at 450 to 500°C) for each of the alloys examined. The amount of H_2 absorbed by Zircaloy-2 is increased mainly as a result of the increased rate of oxidation under irradiation; the fraction of H_2 absorbed is not greatly affected. (auth)

12622 THE MECHANISM OF CARBON TRANSFER IN LIQUID SODIUM. V. S. Lyushenko and B. A. Nevzorov. p.373-408 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Results of investigations concerning C transfer from Fe, carbon steel, perlite steel, and chrome steel to austenitic steel and Ni alloys in oxygenated liquid Na at temperatures up to 650°C are presented. The probable mechanism of C transfer involves the formation of CO on surfaces as the result of reaction between C and O ions and the diffusion of CO through the volume of the reaction followed by adsorption of CO on the surface of steels and alloys. Adsorption is accompanied by catalytic relaxation of the bonds in the CO molecules by detachment of the O atoms on their chemical interaction with the medium. (J.R.D.)

12623 CORROSION OF GRAPHITE BY COOLANT GASES (AIR AND CARBON DIOXIDE). F. M. Lang and P. Magnier (Centre d'Etudes Nucleaires, Saclay, France). p.453-67 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In French)

In the chemical state the dry-gas oxidation rate (air and CO_2) of numerous carbons of widely different origin but highly purified is practically the same. The degree of graphitation seems to have little effect, but humidity and H_2 have a marked influence. Nuclear graphite has a very complex structure and is found in the chemical state only under very limited combinations of temperature and pressure. The porosity and permeability of the materials investigated usually have to be considered, as both affect the oxidation kinetics. The term specific rate cannot be applied to industrial graphite containing impurities, since the oxidation proceeds more rapidly in the–usually localized–contaminated parts. Chemisorption is an intermediate stage in the surface reactions: the absorbed gases (O_2, CO_2, H_2O, H_2. . .) are desorbed mainly as CO and H_2. Using CO_2, irradiated in extremely clean silica vials, a G_{CO} of the order of 1×10^{-4} near 500°C was found. The irradiation of solid CO_2 at the temperature of liquid N_2 gave much larger quantities of CO. (auth)

12624 THE MIGRATION OF ACTIVATED CORROSION PRODUCTS IN HIGH-PRESSURE WATER LOOPS. G. N. Walton and E. Hesford (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.547-56 of "Corrosion of Reactor Materials. Vol. II." Vienna, International Atomic Energy Agency, 1962. (In English)

The migration process is discussed, and it is concluded that the emission process is not controlled primarily by the corrosion rate and the dispersion of solid material by an ionic exchange between ions in the corrosion film and ions in true solution in the water. Figures are obtained for the fractional emission rates of radioactive Fe and Co from the corrosion film of irradiated steel in pressurized water and also for the rates of deposition from the water on to unirradiated steel. These figures are applied to an in-pile, pressurized-water system; and the calculated activity levels are found to be comparable with, and little higher than, the observed levels. Emission and deposition constants are also estimated for some other elements. (auth)

12625 A PROCESS FOR THE ANODIC SURFACE TREATMENT OF ZIRCONIUM, HAFNIUM AND THEIR ALLOYS. (to Aktiebolaget Atomenergi). British Patent 916,190. Jan. 23, 1963. Priority date Sept. 27, 1960, Sweden.

A method was described for the anodic surface treatment of zirconium, hafnium, and their alloys in an aqueous and substantially neutral or slightly alkaline electrolyte. Ammonium nitrate in the electrolyte modified the action of the electrolyte so that no uncontrolled attack upon the anodized metal surfaces took place within a reasonable time after the object was lifted from the bath. (C.E.S.)

Fabrication

Refer also to abstracts 13685 and 13686.

12626 (AD-275787) DEVELOPMENT OF REFRACTORY CERAMICS THAT CAN BE PROCESSED AT TEMPERATURES CONSIDERABLY LOWER THAN THEIR MAXIMUM USE TEMPERATURE. Final Report, December 1, 1960–April 1, 1962. (Rutgers Univ., New Brunswick, N. J. School of Ceramics). Contract NOw-61-0211-c. 49p. (N62-12088).

A presintering process was developed that showed considerable progress. The fabrication technique utilized higher alumina content compositions to reduce the maturing temperatures by 200°F. This was accomplished by a study of the parameters of the presintering operation and the form of the raw material additions. A more fundamental study into the densification mechanisms occurring in this type fabrication is underway. A second approach to a lower maturing temperature is the devitrification process. One aspect of the process is the incorporation of a devitrifiable glass in an alumina matrix. Another is the formation of a glass of refractory composition; this aspect appears promising. The third approach to the overall problem is the application of controllable sintering mechanisms to pure oxide ceramics. This involves a study of the effect of time, temperature, atmospheres, and additives upon the sintering mechanisms of the pure oxide, alumina. To date the apparatus has been constructed and specimens have been prepared for firing and subsequent evaluation. (auth)

12627 (ASD-TR-7-888(Vol.III)) DEVELOPMENT OF ULTRASONIC WELDING EQUIPMENT FOR REFRACTORY METALS. Interim Technical Progress Report, February through April 1962. Nicholas Maropis (Aeroprojects, Inc., West Chester, Penna.). May 1962. Contract AF33(600)-43026. 32p. (AD-277660)

The requirements for a heavy-duty ultrasonic welding system are being analyzed, and associated development problems resolved. High-power ceramic transducer assemblies, power-force programming elements, and switching devices for a motor-alternator power source are being assembled and experimentally evaluated. Current information on refractory metal developments affecting the ultrasonic weldability of such material, as well as data on candidate welding tip materials, is being accumulated and studied. Information is presented for Nb(D-31), Mo-0.5Ti, René 41, and W. Composition and physical properties are summarized for welding tip materials: Astroloy, Udimet 700, Udimet 500, NIMONIC 115, and Nicrotung. A tension-shell transducer unit with increased power-handling capacity was designed, and an acoustic absorber was assembled and utilized. An Al-bronze coupler element was fabricated for a 2-kw ultrasonic welder. (auth)

12628 (GAMD-2221(Rev.)) PROCEDURES FOR THE PREPARATION OF GRAPHITE MATRIX FUEL COMPACTS CONTAINING CARBON COATED $(Th,U)C_2$ FUEL PARTICLES. W. V. Goeddel (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 15, 1962. Contract AT(04-3)-314. 14p.

Details of the warm press fabrication processes are described. It is noted that only 10 wt % of pitch binder is required of which only 5% remains after warm pressing. The resulting product is a high density matrix of 95 vol % graphite and 5 vol % C. (J.R.D.)

12629 (NAA-SR-Memo-6584) SILVER EUTECTIC AMP BONDING DEVELOPMENT. W. R. Jackson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 3, 1961. Contract [AT-11-1-GEN-8]. 16p.

A method of cold-forming tube-to-end plugs prior to silver eutectic bonding is described. It was found that M257 to M257 end closures, that were helium leak tight and inseparable by chiseling, could be produced by cold swaging a steel retaining sleeve onto the closure prior to promoting eutectic diffusion bonding by heat treatment. Heat treatment was accomplished by: (a) heating in an inert atmosphere by an induction coil at ≈1150°F for 10 minutes; (b) heating in an open air electric tube furnace at 1100 ± 15°F for 30 minutes. (auth)

12630 (NP-12521) LA METALLURGIE DES POUDRES. PRINCIPES, PROGRÈS RÉCENTS DE LA TECHNOLOGIE, MATÉRIAUX ET APPLICATIONS. (Powder Metallurgy. Principles, Recent Progress of Technology, Materials and Applications). Claus G. Goetzel (France. Institut National des Sciences et Techniques Nucléaires, Paris and France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). [1961]. 101p.

Discussions are included concerning the mechanical, chemical, and electrolytic methods of obtaining the powder initially, powder processing, slip casting, hydro and isostatic pressing, shaping, sintering and impregnation. Products obtained by use of these methods are reviewed, and applications in nuclear reactor technology are discussed. Other discussion is included on the fundamental theories of sintering. (J.R.D.)

12631 (NP-12539) ALUMINUM WELDING. A Report on the Welding of NPD-2 Reactor Components. William J. Burns (Canadian General Electric Co., Ltd., Peterborough, Ont.). Nov. 1960. 143p.

A record of the welding done in NPD-2 construction is presented which serves to illustrate techniques developed

and used in construction of two vessels in which the weld quality is good. The manual is limited to Al alloy and to the metallic-inert-gas and W-inert-gas techniques. (J.R.D.)

12632 (NYO-10215) DEVELOPMENT OF UNIQUE METHODS FOR RADIOACTIVE SOURCE FABRICATION. VIBRATORY COMPACTION. Quarterly Progress Report II. (General Scientific Corp., Washington, D. C.). Oct. 1962. Contract AT(30-1)-2981. 36p.

Work during the period was devoted primarily to design simplification, compaction mechanism, fabrication, and initiation of testing. The initial design of the coupling between the loading mechanism and the source container was complex, however this design was simplified by using elastomeric seals which could be replaced after losing their usable properties through radiation damage. Fabrication of the source container and holding mechanism is reported. The holding mechanism utilizes a spring loaded chuck for fastening the source container to the vibratory table. A simplified static loading mechanism was designed to be used for testing purposes only. A picture of the completed test rig is included. A prior and more extensive design would be required for a usable unit. The simplified design has been fabricated and attached to the vibratory table. All commercial equipment and materials including the CeO_2 and $SrTiO_3$ powders were received. Compaction tests utilizing single size particles of CeO_2 and no static load were performed in which a theoretical density of 50% TD was achieved. This value approaches that predicted by the packing theory for single size spherical particles. Since the particles are not 100% TD, the results will ultimately be reported as packing efficiency instead of percent of theoretical density. The $SrTiO_3$ powders were classified into particle sizes and compaction tests are in progress. (auth)

12633 (TID-17862) SPECIFICATION FOR FABRICATION AND TESTING OF TITANIUM VESSELS AND COMPONENTS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 15, 1961. Contract [W-31-109-eng-52]. 8p. (HWS-7441)

A detailed specification covering the requirements for fabrication, testing, inspection, and shipping of titanium vessels for the chemical processing of highly radioactive solutions is presented. (H.G.G.)

12634 (EURAEC-378) WELDING OF VERY THICK STEELS. Quarterly Report No. 3, April 1 to June 30, 1962. (Soudometal, S. A., Brussels and Ghent. Rijksuniversiteit). Work Performed under United States–Euratom Joint Research and Development Program. 219p. Contract 042-61-9 RDB. A translation.

Effort during the period was devoted mainly to investigation of gas-confinement effects in deep narrow chamfers, parameters affecting welding products, brittle fracture criterion in 100 mm plates, mechanical properties of manually welded vertical and horizontal 100 mm joints, and embrittlement and annealing of base metals. (J.R.D.)

12635 (EURAEC-461) PRODUCTION OF SWAGED FUEL ELEMENTS. Quarterly Report No. 9, July 1 to September 30, 1962. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 062-61-7RDD. 40p. A translation.

Continued burn-off tests on W electrodes in the UO_2 melting furnace are reported. An increased burn-off observed in the fusion process was found to be the result of electrode oxidation. Swaging experiments on 2 × 0.5 mm V2A-tubes of 400 mm length are reported. In pre-packing tests of fused UO_2 powder it was found that vibration of a 1 m column for 10 min yielded powder density of 85% of theoretical. The swaging experiments with the two-jaw machine were concluded. Results with this machine showed that for a total diameter reduction of 36%, densities of over 92% of the theoretical value could be attained with fair reproducibility. (J.R.D.)

12636 (EURAEC-501) BASIC STUDY OF SOME OF THE FORMS OF EMBRITTLEMENT OCCURRING IN WELDED JOINTS MADE ON HIGH TENSILE STEEL. Quarterly Report No. 3, July 1 to September 30, 1962. (Société Anonyme des Forges et Ateliers du Creusot, Paris). Work Performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12 RDF. 15p. A translation.

Work during the quarter was directed toward initial operation of the machine to be used in simulating thermal cycles produced during welding operations. Other work is reported on rod impact strength tests in which the brittle fracture temperatures were defined in the case of A-42 and A-52 steels. Various studies of castings are reported in which about 60 experimental 20 kg castings were produced. Relations between gamma grain size increase in high-tensile steel and heat treatment time at 850 to 1300°C were established. Embrittlement tests on hardened and tempered specimens are in progress. (J.R.D.)

12637 ACTIVATED SINTERING OF URANIUM DIOXIDE FUEL. I. SINTERING IN HYDROGEN. Kazuo Maruya, Shuichiro Takahashi, Kosho Watanabe, and Tadashi Ogura (Mitsubishi Atomic Power Ind. Inc., Japan). Nippon Genshiryoku Gakkaishi, 4: 845-51(Dec. 1962). (In Japanese)

UO_2 powders with a small amount of the additives TiO_2, BeO, Al_2O_3, MgO, V_2O_5, ZrO_2, CaO, and CeO_2 are sintered at 1,400 to 1,700°C for 1 to 9 hr in hydrogen. Accelerating effects of these additives on sintering are determined by the densities and porosities of the sintered pellets and the microscopic structures of their free surfaces. Addition of TiO_2 pronouncedly accelerates the sintering rate of UO_2. Even its slight addition is effective in lowering the sintering temperature. Thus high sintered density is obtained. BeO and Al_2O_3 are also notably effective in accelerating the sintering rate. The next effective additive among the oxides in this experiment is MgO. Maximum accelerating effect of TiO_2 is observed at 0.3% and that of BeO at 0.03%. Only minor effects are observed for the addition of V_2O_5, ZrO_2, and CaO, and nearly no effect for CeO_2. (auth)

12638 STUDY OF THE EMBRITTLEMENT OF MANGANESE–MOLYBDENUM WELDABLE STEELS DURING STRESS-RELIEF ANNEALING AFTER WELDING. P. F. Martin, C. Roques, and P. Bastien. Rev. Met. (Paris), 59: 829-43(Oct. 1962). (In French)

A shift in the curves for the change in toughness was observed for three typical steels after being held for 1 to 100 hours at temperatures from 400 to 700°C and after cycling corresponding to stress-relief anneals at 625°C. A comparison is made with carbon–manganese steels. Embrittlement increases with the temperature and time of annealing and is reversible and independent of cooling after the aging treatment. (auth)

12639 NEUTRON-SHIELD MATERIALS. [PART] I. FUNDAMENTAL STUDIES ON BORAL-INGOT PREPARATION. Tetsuzo Atoda and Yoshihiko Sasa. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 56: 244-57(Dec. 1962).

Fundamental studies were made for the purpose of establishing an industrial production method for Boral. Factors that affect the preparation of a sound ingot were determined in detail and a simple method for production

was established. Transparent granular anhydrous boron oxide in quantity of 5 percent of required weight of boron carbide was fused into molten aluminum in a clay-graphite crucible. Boron carbide was mixed into the melt slowly for homogeneous dispersion. Sound Boral-ingots were obtained with a yield between 70–90% by top-pouring the Boral melts into molds. When the mixture was allowed to cool and then remelted in a titania-lined crucible and top-poured into a mold, a yield of nearly 100% was obtained. (auth)

12640 NEUTRON-SHIELD MATERIALS. [PART] II. CASTING OF LARGE-SIZE BORAL-INGOT. Tetsuzo Atoda and Yoshihiko Sasa. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 56: 258-62(Dec. 1962).

A method of producing Boral-ingot is standardized for industrial procedure. For the confirmation of applicability of the method to large scale production of Boral-ingot, present work on casting Boral-ingot of weight between 5.5 and 11.8 kg which contained 35 and 40 percent by weight of boron carbide is made. The method is proved to produce Boral-melt of excellent fluidity whereby very sound ingots of homogeneously dispersed boron carbide can be cast with yield of nearly 100 percent. The proposed method is, therefore, concluded to be applicable to industrial production of large-size Boral-ingots satisfactorily. (auth)

12641 GRAPHITE MACHINING IN THE MARCOULE SHOP. G. Deleuze (Societe des Forges et Aletiers du Creusot, Paris). Preprint S5-11. Prepublication Copy. 5p.

The shop where graphite is machined for French reactors is described. The air-conditioning and dust-removal equipment was carefully designed. Photographs of the shop and machines are described, but the photographs are not included in the preprint. (M.P.G.)

12642 MANUFACTURE OF FUEL ELEMENTS OF THE GRAPHITE–CARBON DIOXIDE SYSTEM. J. Nadal (Societe Industrielle de Combustible Nucléaire, [France]) and M. Boussard. Preprint S7-14. Prepublication Copy. 14p.

Fuel elements of natural U encased in impervious cans of Mg or Mg alloy are manufactured for the G-1, -2, and -3 reactors of Marcoule and the EDF-1 and -2 reactors of Chinon. The manufacturing process can be divided into four parts: melting and casting of U under vacuum; preparation of cast rods, including heat treating, cleaning, and degassing; preparation of cans and end caps; and canning, including welding the end caps, cladding, and checking for fluid tightness. Each part of the manufacturing process is described. The essential features of the manufacture of fuel elements are the importance of inspection tests, the observation of strict cleanliness, and the "mass production" character of the manufacturing process. (M.P.G.)

12643 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF BUILDING MATERIALS. Conrad Lawrence Walsh. British Patent 904,889. Sept. 5, 1962. Filed Nov. 21, 1958.

A method is given for manufacturing building blocks or slabs with greater density and breaking strength for radiation shielding. The method comprises adding to cement or cementitious material an additive to render it moisture-resistant, and iron in a finely divided form. The additive may be either a fatty acid or a mixture of fatty acid and cetyl alcohol in a proportion of 0.01 to 2 wt %, preferably 0.25 wt %. The proportion of iron may be between 55 and 95 wt %. (D.L.C.)

12644 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Roy Stuart Butterfield (to United Kingdom Energy Authority). British Patent 915,503. Jan. 16, 1963. Filed Jan. 21, 1960.

Improved leak-resisting properties of a close-fitting containment for nuclear fuel elements were described. (C.E.S.)

12645 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Brendan Orrell, Roy Stuart Butterfield, and Kenneth Foster (to United Kingdom Atomic Energy Authority). British Patent 915,652. Jan. 16, 1963. Filed Jan. 21, 1960.

This invention was concerned with nuclear fuel elements of the type comprising fissile material contained in a tubular sheath, the ends of the sheath being closed by end caps sealed to the sheath. According to this invention, a nuclear fuel element was characterized in that the end cap seals were shrouded and the shrouds sealed to the sheath of the fuel element to prevent mechanical damage during loading into the reactor core. (C.E.S.)

12646 IMPROVEMENTS IN OR RELATING TO THE MACHINING OF CYLINDRICAL FINNED BODIES. Eric William Vickers Acton, David Frederick Hillier, and Donald Edward Ross (to General Electric Co. Ltd.). British Patent 916,608. Jan. 23, 1963. Filed Apr. 27, 1959.

A machine was provided for machining a parallel sided helical slot or passage through the fins of a finned cylindrical body, such as a nuclear fuel element can. (C.E.S.)

12647 PROCESS FOR APPLYING A STEEL OR IRON COVERING TO THE CANS OF NUCLEAR REACTOR FUEL ELEMENTS. (to Deutsche Gold-und Silber-Scheidenstalt Vormals Roessler). British Patent 916,618. Jan. 23, 1963. Priority date Feb. 14, 1959, Germany.

A process for covering cans of nuclear reactor fuel elements with steel or iron was described. The elements can be operated at relatively high temperatures in reactors without the danger of reducing the mechanical and thermal strength and the resistance to corrosion. (C.E.S.)

12648 NEUTRON-ABSORBING CONSTRUCTION-PARTS FOR NUCLEAR REACTORS AND PROCEDURE FOR THE MANUFACTURE. (to Gebr. Böhler and Co. Aktiengesellschaft). British Patent 917,015. Jan. 30, 1963. Priority date July 26, 1958, Austria.

A simple and inexpensive procedure was described for the manufacture of structural parts for nuclear reactors. The parts were characterized by their strong tendency to absorb neutrons, and they were able to resist efficiently the stresses occurring. The structural parts consisted of unalloyed or low-alloy sintered iron or steel with a corrosion-resistant coating. (C.E.S.)

12649 FABRICATION OF CARBON AND GRAPHITE BODIES. (to Great Lake Carbon Corp.). British Patent 917,097. Jan. 30, 1963. Priority date Aug. 5, 1960, United States.

A method for fabricating carbon and graphite bodies was described. The dimensions of the bodies were considerably greater and shapes more intricate than those produced by existing methods. The method consisted of cementing or bonding the component pieces together while they were still in the "green state" followed by a baking operation that permanently joined the bodies together. (C.E.S.)

12650 IMPROVEMENTS IN RADIOACTIVE REFRACTORY PARTICLES. (to Minnesota Mining and Mfg. Co.). British Patent 917,649. Feb. 6, 1963. Priority Jan. 30, 1958, United States.

A method is given for making small refractory particles

in which radioactive ions are dispersed and firmly fixed to resist removal at temperatures up to 1000°C. In the method, a batch of inorganic oxides is melted at 1100 to 1500°C, quenched in water to form glass frit particles, and formed into spheres. The spheres are placed in an acid solution to leach the acid-soluble, nonrefractory constituents therefrom, then placed in solutions of radioactive ions to absorb these ions within the leached pores, and dried and raised to 1000 to 1200°C to devitrify the matrix. The particles are treated briefly with acid solution to remove ions from the outer surfaces and dried for use. Several examples of the preparation and properties of such particles are given. (D.L.C.)

12651 PRODUCTION OF NUCLEAR FUELS, MODERATORS, OR CONTROL MEMBERS. (to Office National d'Etudes et de Recherches Aeronautiques). British Patent 918,044. Feb. 13, 1963. Priority Date Feb. 14, 1958, France.

A method is given for fabricating a solid product for use in a reactor as a fuel, a moderator, or a control member. The solid product comprises a fuel and/or moderator or a control element of finely divided form mixed with a finely divided metallic constituent; the mixture is sintered in an atmosphere containing H_2, a halogen, and a chromium halide. The metallic constituent should be one of the group Fe, Ni, Co, Cr, Mo, and alloys thereof, and the fuel, moderator, or control element should have a heat of formation high enough not to be reduced by the metallic constituent during the sintering operation. The resulting solid products have a very uniform composition and good mechanical properties. (D.L.C.)

12652 METHOD OF MAKING AND PLATE CONNECTION. P. Patriarca, C. E. Shubert, and G. M. Slaughter (to U. S. Atomic Energy Commission). U. S. Patent 3,078,551. Feb. 26, 1963.

This invention relates to a method of joining, by welding or brazing, a tube to a plate, particularly where the tube and the plate are of different thickness or have different thermal conductivities and are subject to high temperatures. In this method the tube is inserted in the core of a plate containing an annular groove in its back face concentric with the bore and in communication with the bore. One end of the tube is welded substantially flush with the front end of the plate. Brazing alloy is placed in the groove on the back face of the plate and heat is applied to the plate and tube to melt the brazing alloy to permit the alloy to flow into the bore and bond the tube to the plate. (AEC)

12653 BRAZING ALLOYS. R. G. Donnelly, R. G. Gilliland, and G. M. Slaughter (to U. S. Atomic Energy Commission). U. S. Patent 3,079.251. Feb. 26, 1963.

A brazing alloy which, in the molten state, is characterized by excellent wettability and flowability, said alloy being capable of forming a corrosion resistant brazed joint wherein at least one component of said joint is graphite and the other component is a corrosion resistant refractory metal, said alloy consisting essentially of 20 to 50 per cent by weight of gold, 20 to 50 per cent by weight of nickel, and 15 to 45 per cent by weight of molybdenum. (AEC)

12654 METHOD FOR PREPARING URANIUM MONOCARBIDE–PLUTONIUM MONOCARBIDE SOLID SOLUTION. A. E. Ogard, J. A. Leary, and W. J. Maraman (to U. S. Atomic Energy Commission). U. S. Patent 3,082,163. Mar. 19, 1963.

A method is given for preparing solid solutions of uranium monocarbide–plutonium monocarbide. In this method, the powder form of uranium dioxide, plutonium dioxide, and graphite are mixed in a ratio determined by the equation: $xUO_2 + yPuO_2 + (2+z)C \rightarrow U_xPu_yC_z + 2CO$, where x + y equal 1.0 and z is greater than 0.9 but less than 1.0. The resulting mixture is compacted and heated in a vacuum at a temperature of 1850°C. (AEC)

Properties and Structure

Refer also to abstracts 12063, 12065, and 12301.

12655 (AD-277776) MECHANICAL AND CHEMICAL PROPERTIES INVESTIGATION OF F48 COLUMBIUM ALLOY. Report 8887. Robert R. Wilcox (McDonnell Aircraft Corp., St. Louis). Jan. 31, 1961. Contract AF33 (657)-7749. 8p.

Three lap shear specimens, each containing a $\frac{1}{8}$ in.-diam F48 niobium rivet, (base material also F48 columbium) and four riveted samples for metallographic examination were submitted for tests. The shear specimens were tested in a 5000 lb Baldwin Test Machine. The four riveted specimens were prepared metallographically, examined, and photographed. Although the texture of the universal heads appears to be heavy, metallographic examination indicates that the surface condition is superficial in nature, and reveals no evidence of cracks or other defects. A ceramic spall coating was tested for oxidation protection of Nb alloy F48 at 2400°F for 2 hours. Coatings did not spall off on cooling but adhered strongly to the Nb alloy. The coatings provided oxidation protection to the Nb alloy (except at edges); however, the Nb alloy panels were very brittle after the heat treatment indicating that contamination limits were exceeded. (auth)

12656 (AD-277779) THE EVALUATION OF A DIFFUSED ALUMINUM COATING FOR VANADIUM BASE ALLOYS. Final Report. Report No. 8890. Jack P. O'Connor (McDonnell Aircraft Corp., St. Louis). Oct. 18, 1961. Contract AF33(657)-7749. 33p.

Vanadium base alloys are characterized by their excellent cold rolling properties, formability, weldability, and strength-to-weight ratio up to 2000°F, but possess poor oxidation resistance at elevated temperatures. LS-866 aluminum base slurry coating was applied to V-60% Nb and V-5% Ti-20% Nb alloys to see if adequate oxidation protection could be achieved up to 2000°F for long exposures (4 hours) and 2500°F for 15 minutes. Specimens were tested by heating in a resistance heating apparatus at 1500, 1600, 1800, 2000, and 2500°F. The LS-866 aluminum paste coating prevents gross oxidation of the base material at temperatures to 1800°F. The 2000°F specimens did not withstand the four hour exposure, although the results appeared promising and exceeded those reported in published information. The 2500°F exposures were satisfactory. On the basis of test results it is recommended that the diffused aluminum coating for vanadium base alloys be investigated further to improve the coating application and optimize the oxidation protection. (auth)

12657 (AD-277910) INVESTIGATION OF MOLYBDENUM- AND TUNGSTEN-BASE ALLOY SHEET MATERIALS. Quarterly Report No. 4, February 25, 1962–May 24, 1962. Gordon D. McArdle, Robert Q. Barr, and M. Semchyshen (Climax Molybdenum Co. of Michigan, Detroit). Contract NOw 61-0581-d. 9p.

Elevated-temperature tensile tests were conducted on several Mo- and W-base sheets which had been rolled to size in air on conventional mill equipment. Hardness measurements, recrystallization data, and bend transition temperature determinations were obtained on sheets of similar analysis rolled in the InFab facility. (auth)

12658 (ANL-6591) THERMAL EXPANSION OF ALPHA-ZIRCONIUM SINGLE CRYSTALS. Lowell T. Lloyd (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 41p.

Single crystals of alpha Zr were used to measure, between room temperature and 860°C, the thermal expansions in the two principal crystallographic directions of the hexagonal-close-packed structure. The measurements were made with a dilatation interferometer. Equations which represent the lengths along the a and c axes and volume as functions of temperature are included. These results do not differ greatly from previous thermal expansion data which were obtained by measurements of the lattice constants at various temperatures, however the dilatation data are for the entire temperature range, whereas the lattice-constant data were for two different ranges. The dilatation data indicate that the lattice constants at the higher temperature were subject to error because of contamination by gaseous impurities. (auth)

12659 (ANL-6631) INVESTIGATIONS IN THE SYSTEM URANIA-NEODYMIA. D. Kolar, J. H. Handwerk, and R. J. Beals (Argonne National Lab., Ill.). Dec. 1962. Contract W-31-109-eng-38. 24p.

Urania-neodymia compositions were sintered in air and in hydrogen. The compositions were studied by chemical, x ray, and differential thermal analyses. Solid solutions formed readily in air-sintered compositions in the range from 20 to 60 m/o Nd_2O_3. Solid solutions formed slowly and incompletely, up to 1650°C, in hydrogen-sintered compositions. There was good correlation between the differential thermal analyses and the chemical and x ray analyses. (auth)

12660 (ATL-A-128) DEVELOPMENT OF HIGH-STRENGTH TERNARY AND QUATERNARY THORIUM-URANIUM BASE ALLOYS. Final Report. R. H. Cole and L. E. Wilkinson (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Nov. 1, 1961. Includes appendices: A. TENSILE TESTING RESULTS. B. STRESS-RUPTURE TESTING RESULTS. Contract AT (04-3)-250. 157p.

The addition of alloying elements to base alloys of Th containing 5 and 10 wt % U was investigated with regard to alloy structures and elevated-temperature mechanical properties. The alloys developed possess elevated-temperature tensile and stress-rupture strengths of essentially twice those associated with binary Th-5 and 10 wt % U alloys at 600 to 800°C. The greater strength of these alloys should result in improved resistance to radiation-induced swelling at high temperatures. Noticeable improvement in elevated-temperature mechanical properties resulted from the addition of 2 and 5 wt % Zr to the Th-5 and Th-10 wt % U base alloys. Zr was found to be the most effective additive in improving elevated-temperature mechanical properties, although significant improvement was noted with additions of Nb, Mo, C, Al, and Be. Both solid-solution strengthening and dispersion strengthening of the Th-U base alloys were encountered. It was found that a fine intragranular distribution of the secondary U phase improved the mechanical properties of the alloys studied. Structures with optimum properties were produced by careful control of the arc-melting procedure and by solution heat treating at 1350°C followed by aging at 850°C. Preliminary testing was performed to determine the elevated-temperature mechanical properties of Th metal and of the Th-U base alloys. Irradiation specimens of the most promising alloys were prepared. These specimens were encapsulated and are ready for irradiation testing at 800°C and for subjection to burnups of 10,000, 20,000 and 30,000 Mwd/ton. (auth)

12661 (BM-RI-6175) HIGH-TEMPERATURE HEAT CONTENTS AND ENTROPIES OF THE SESQUIOXIDES OF ERBIUM, HOLMIUM, THULIUM, AND YTTERBIUM. L. B. Pankratz and E. G. King (Bureau of Mines. Berkeley Thermodynamics Lab., Berkeley, Calif.). July 1962. 10p.

The heat contents of the sesquioxides of Er, Ho, Tm, and Yb (Er_2O_3, Ho_2O_3, Tm_2O_3, and Yb_2O_3) in the cubic crystalline form were measured at 298 to 1,800°K. The Er and Ho sesquioxides gave regular heat content-temperature curves. Tm_2O_3 sesquioxide had a minor thermal anomaly near 1,680°K, with a heat absorption of 310 cal/mole; similarly, Yb_2O_3 had a minor anomaly near 1,365°K, with a heat absorption of 150 cal/mole. The heat content results are presented in both tabular form (at 100° intervals) and in algebraic form. Entropy increments, corresponding to the tabulated heat content results, also are listed. (auth)

12662 (CRRP-1124) DIFFUSION OF FISSION GAS. CALCULATED DIFFUSION FROM A SPHERE TAKING INTO ACCOUNT TRAPPING AND RETURN FROM THE TRAPS. D. G. Hurst (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 15, 1962. 50p. (AECL-1550)

One method of determining a diffusion coefficient is to measure, as a function of time, the fractional leakage of the diffusing material from small grains of the matrix and to compare the measured curve with the curve calculated for leakage from spheres. The measured curve often departs widely from theory, and qualitative explanations are then given for the differences. An important example is the diffusion of rare-gas fission products from UO_2. The calculations can be brought into closer agreement with experiment if it is assumed that atoms may be trapped and thus prevented from further diffusion, at least for some time. Computed values of the fractional escape from spheres and a few comparisons between theory and experiment are presented. (auth)

12663 (DC-61-7-10) PRELIMINARY REPORT OF X-RAY STUDIES ON THE BeO-Y_2O_3 SYSTEM. S. F. Bartram (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Apr. 19, 1961. Contract AT(11-1)-171. 16p.

Observations on the reaction of BeO with Y_2O_3 are reported. Three definite compounds have been characterized, two of these have never before been mentioned in the literature. Crystallographic and petrographic examination of various BeO-Y_2O_3 reaction products have confirmed the existence of three compounds in this binary system. X ray analysis and crystal symmetry considerations indicate the probable compositions to be: BeO · Y_2O_3, 4BeO · Y_2O_3 and 9BeO · Y_2O_3. Chemical identification has been impossible because no single phase preparations have been made. From a limited amount of non-equilibrium results on this system, a tentative phase diagram was constructed. Considerable further work is necessary before a reliable diagram can be drawn. Single crystals of each of the BeO-Y_2O_3 compounds were found. This permitted the unequivocal indexing of the powder diffraction patterns. X ray and optical data are tabulated. (auth)

12664 (GEAP-4060) REMARKS CONCERNING MATERIALS FOR NUCLEAR SUPERHEAT FUEL CLADDING. H. H. Klepfer, D. L. Douglass, W. V. Cummings, M. B. Reynolds, and K. C. Antony (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Sept. 4, 1962. Contract AT(04-3)-189. 45p.

A summary of information concerning nuclear super-

heater cladding development is presented. Comment is included concerning consideration of other alloys which are potential alternates to stainless steel. Data and information are included on corrosion, physical metallurgy, and radiation effects. (J.R.D.)

12665 (GEAP-4095) EVALUATION OF 300 SERIES STAINLESS STEEL TUBING FOR FUEL CLADDING. R. F. Kirby (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1962. Contract AT(04-3)-189. 33p.

An evaluation program was undertaken to determine the quality of commercially available 300 series stainless steel tubing and establish acceptance standards and specifications for such tubing used to fabricate fuel elements for nuclear superheat applications. The evaluation was accomplished by determining the occurrence frequency and character of tubing defects using ultrasonic techniques. The effects of these defects upon tubing burst strength were determined by burst testing artificially defected tubing samples at 1250 to 1350°F. Tensile tests were performed on tubing samples at 1300°F to extend the knowledge of tubing tensile properties into the temperature range expected in superheat applications. Based on the information obtained, material specifications were prepared for purchasing 300 series stainless steel tubing suitable for nuclear superheat fuel cladding. (auth)

12666 (NA57H-527-17) DOD HIGH STRENGTH TITANIUM ALLOY SHEET RESEARCH PROGRAM. Progress Report No. 17. D. E. Myers (North American Aviation, Inc., Columbus, Ohio). May 31, 1962. Contract NOas 57-785d. 212p. (AD-277933).

Metallurgical, formability, joining, and machining data for the 5Al–5Sn–5Zr and 7Al–12Zr super alpha-Ti sheet alloys are presented. The evaluations are complete with the exception of creep studies at 900 and 1100°F, and fabrication sequences (stress and contamination studies) investigations. (auth)

12667 (NAA-SR-7654) HIGH TEMPERATURE PHASE TRANSFORMATION IN BERYLLIUM OXIDE: THERMAL ARREST MEASUREMENTS. S. B. Austerman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1963. Contract AT(11-1)-Gen-8. 18p.

Beryllium oxide exhibits a thermal arrest during rapid heating and cooling in the vicinity of 2100°C. This is evidence of a high-temperature phase transformation, which has also been detected by other means. The latent heat of transformation was measured to be 50 ± 10 cal/g of BeO, based upon a specific heat of 0.577 cal/g at 2100°C for BeO. (auth)

12668 (NRL-5874) HALL COEFFICIENT OF SUPERCONDUCTING AND NORMAL Nb–25% Zr. Interim Report. A. I. Schindler and D. J. Gillespie (Naval Research Lab., Washington, D. C.). Nov. 9, 1962. 7p.

Hall-coefficient measurements were made on cold-rolled Nb–25% Zr in the zero-resistance mixed state at 4.2°K and in the normal state at 4.2, 77, and 317°K. At sample current densities from 2×10^3 to 1×10^4 amp/cm^2 in fields of 1 and 9 kilogauss, no Hall voltage for the superconducting sample could be observed with equipment capable of detecting voltages as small as 10^{-9} volt. An upper limit of the superconducting Hall coefficient was calculated to be 10^{-15} m^3/amp-sec. The values of the Hall coefficient for Nb–25% Zr in the normal state are 1.14×10^{-10}, 1.05×10^{-10}, and 0.84×10^{-10} m^3/amp-sec at 4.2, 77, and 317°K, respectively. (auth)

12669 (RAD-SR-63-29) MICROSTRUCTURE STUDIES OF POLYCRYSTALLINE REFRACTORY OXIDES. Quarterly Progress Report No. 2. T. Vasilos, R. M. Spriggs, and J. B. Mitchell (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). Feb. 14, 1963. Contract Now 62-0648C. 22p.

Transverse bend strength and elastic modulus determinations made of fine-grained (1 to 2 micron), dense, pure Al_2O_3 and MgO specimens as a function of temperature (up to 1350°C) revealed values higher than those obtained by other investigators for these oxides in more porous form and of larger grain sizes. Studies of the grain growth kinetics of alumina and magnesia were conducted in order to obtain information to enable preparation of specimens with desired larger grain sizes for subsequent thermomechanical testing. Based on observations of the fracture modes exhibited by alumina and magnesia as a function of temperature, it was suggested that an elastic deformation or possible plastic flow in the so-called "equicohesive" temperature range may influence the mode of fracture. By analogy with findings in metals systems, it was hypothesized that the apparent transition from transgranular to intergranular fracture might occur below some critical stress rather than above some critical temperature. (auth)

12670 (TID-17915) THE FERROELECTRIC-ANTIFERROELECTRIC TRANSITION AND DIELECTRIC PROPERTIES IN THE TERNARY SYSTEM $PbZrO_3$–$PbHfO_3$–$PbTiO_3$. Charles A. Hall (Sandia Corp., Albuquerque, N. Mex.) and Ralph L. Cook (Illinois. Univ., Urbana). [Jan. 1963]. Contract [AT(29-1)-789]. 16p. (SCDC-2985)

An investigation of the ferroelectric-antiferroelectric transition and dielectric properties in the ternary system $PbZrO_3$–$PbHfO_3$–$PbTiO_3$ was made. Five phases were found in the region of the ferroelectric-antiferroelectric phase boundary. (J.R.D.)

12671 (UCRL-7128) HIGH-PRESSURE INVESTIGATIONS OF GROUP III ELEMENTS. PART I. FUSION CURVES AND POLYMORPHIC TRANSITIONS OF ALUMINUM, GALLIUM, INDIUM, AND THALLIUM AT HIGH PRESSURES. A. Jayaraman, W. Klement, Jr., R. C. Newton, and G. C. Kennedy. PART II. PHASE TRANSFORMATIONS IN URANIUM AT HIGH PRESSURES. W. Klement, Jr., A. Jayaraman, and G. C. Kennedy (California. Univ., Los Angeles. Inst. of Geophysics). Nov. 1, 1962. For Univ. of California, Lawrence Radiation Lab., Livermore. Contract W-7405-eng-48. 38p.

The fusion curves of Al and Tl to 50 kbar, and of Ga to 70 kbar, were investigated by differential thermal analysis (DTA). Comparison is made with previous work and with the fusion curve of In. A break in slope of the melting curve of Ga near 45°C and 30 kbar led to the discovery of a new polymorph. This phase—Ga III—is slightly less dense than Ga II, both persisting to 75 kbar. Solid-solid phase boundaries for Ga and Tl were determined by changes in volume and resistance as well as with DTA. The Ga II to Ga III transition is rapid and characterized by a substantial heat as well as a drop in resistance. From the investigation of the metastability phenomena, it is tentatively concluded that Ga III is identical with Bridgman's Ga II' and that the metastable phase studied by Defrain at one atmosphere is closely related to Ga II. The existence of three polymorphs of Tl is definitely established, although the undercooling noted by Ponyatovskii for the bcc-hcp transition was verified. The triple point for the solid Tl phases is near 115°C and 39 kbar, with melting of the high-pressure polymorph ex-

pected above 650°C and 90 kbar. The α-β, β-γ, and the direct α-γ phase transformations in U were studied up to 45 kbar at cooling and heating rates of 3 to 5°C/sec. The overheating and undercooling intervals for the α-β and β-γ transformations at high pressures are about the same as the hystereses expected at zero pressure and do not vary appreciably with increasing contamination. Progressive contamination and resultant lowering of the transformation temperatures of the U samples were evident for all containers used, but were least for Ta containers. The equilibrium α-β-γ triple point occurs at less than 31.5 kbar and greater than 803°C. The γ phase is definitely more compressible than the β phase, and the β phase is probably more compressible than α. There is only a small hysteresis in the α-γ transformation. (auth)

12672 (AEC-tr-5626) THE VAPOR PRESSURE OF BINARY METAL ALLOYS. Axel Wejnarth. Translated for Ames Lab., Ames, Iowa from Tek. Tidskr., No. 5, 33-9(May 9, 1942) and No. 5, 44-8(June 13, 1942). 23p.

The carrier method affords the most suitable experimental equipment in the study of vapor pressures for binary alloys within the systems Cd–Mg and Zn–Mg, with hydrogen being the best carrier. The components of the metal alloys formed within a binary system show unequally great affinity toward one another, which agrees with the fact that many of them exist in the molten state even at high temperatures over their melting points. Experiments showed the affinity of Fe and Zn compounds to be greater than that of Mg and Zn compounds. This constitutes an exception to the rule as regards the affinity of compounds between a binary metal system of "non-inert" and "inert" metals. Two distillation processes for obtaining pure magnesium and pure zinc were discussed. (H.G.G.)

12673 NOTE ON THE STRUCTURE OF ScP AND YP. Erwin Parthé and Edda Parthé (Univ. of Pennsylvania, Philadelphia). Acta Cryst., 16: 71(Jan. 10, 1963). (In English)

An x-ray investigation of samples of ScP and YP showed that both compounds crystallize in the NaCl(B1) structure. The lattice constants are 5.312 Å for ScP and 5.661 Å for YP. (P.C.H.)

12674 REFRACTORY CERAMICS AND INTERMETALLIC COMPOUNDS. W. G. Ramke and J. D. Latva (Metals and Ceramics Lab., Wright-Patterson AFB, Ohio). Aerospace Eng., 22: No. 1, 76-84(Jan. 1963).

Possible aerospace applications of refractory nonmetallics are described briefly. The available data on the properties of carbides, borides, and beryllides are summarized in tables. The probable applications and future trends are discussed. (D.L.C.)

12675 DESIGN WITH RATE-SENSITIVE CERAMICS. E. G. Bodine (Battelle Memorial Inst., Columbus, Ohio). Aerospace Eng., 22: No. 1, 100-7(Jan. 1963).

A brief review of the principles employed in designing with brittle ceramic materials is presented together with an introduction into the methods being used to account for strain rate effects at high temperatures. Data on a ceramic dispersion of BeO with UO_2 are presented to illustrate these methods. (auth)

12676 TEMPERATURE CHARACTERISTICS OF BeO TUNNELING STRUCTURES. John G. Simmons, George J. Unterkofler, and William W. Allen (Burroughs Corp., Paoli, Penna.). Appl. Phys. Letters, 2: 78-80(Feb. 15, 1963).

A Be–BeO–Au structure with current-voltage characteristics that are temporarily stable and relatively temperature-insensitive was described. Chrome–gold contacts, arranged to facilitate four terminal electrical measurements, were evaporated onto a glass substrate at a vacuum of 10^{-7} Torr. Ten $\frac{1}{16}$-in. beryllium strips were evaporated onto the substrate and oxidized. A $\frac{1}{16}$-in. gold strip was evaporated over each of the Be–BeO strips. The devices were never exposed to the atmosphere during fabrication. The exponential high-voltage and linear low-voltage current-voltage characteristics, together with the relative temperature-insensitivity, provided good evidence that tunneling was the conduction mechanism. (C.E.S.)

12677 HEATS OF FORMATION OF UFe_2 AND U_6Fe. M. I. Ivanov and N. S. Podol'skaya. At. Energ. (USSR), 13: 572-5(Dec. 1962). (In Russian)

The heats of formation of UFe_2 and U_6Fe were measured calorimetrically, using a previously described method (Atomnaya Energiya, 5: 166(1958) No. 2). The compound UFe_2 was prepared by heating a stoichiometric mixture of U and Fe to 1270 ± 20°C at 700 mm of Hg. The heat of formation of the compound, obtained from the difference between the heats of solution of UFe_2 and of the stoichiometric mixture U + 2Fe was found to be $-\Delta H^0_{298°K} = 7.7 \pm 0.3$ kcal/mol. The heat of formation of U_6Fe, calculated from the equation $UFe_2 + 11U = 2U_6Fe$ + O cal (because it is obtained by a peritectic reaction with a decomposition temperature considerably below the melting point of UFe_2) was found to be $-\Delta H^0_{298°K} = 3.9$ kcal/mol; the error probably does not exceed 30%. Electropolished U and Fe prepared from its carbonyl compound were used for the tests. (TTT)

12678 THE AFFINITY OF NIOBIUM TO OXYGEN. G. A. Meerson and T. Segorceanu. At. Energ. (USSR), 13: 597-9(Dec. 1962). (In Russian)

The oxidation resistance of the refractory Nb and the reducibility of its oxide is discussed. The mechanism of the reduction of the oxide by Ca and Mg was studied for the purpose of determining the equilibrium amount of O in the system as the reaction with Ca and Mg was carried out in the direction of reduction and of oxidation. Metallic Nb powder containing 5% O by weight (~2.5 at. %), prepared by the reduction of Nb_2O_5 with Mg, was used for the experiments. The Nb powder was mixed with 99.9% pure Mg powder or with 99.85% pure Ca shavings, using amounts 4 times larger than the theoretical required reducing agent. The briquetted mixture was heated to 1000°C in a CaO-lined casing for 6 hours, then cooled rapidly. The results showed that at 1000°C Ca reduces the Nb oxides to a powdery solid solution of O in Nb having a low O content of 0.1 to 0.2 wt %; Mg yields similar solid solutions with an O content of 0.2 wt %. On the basis of these data and those reported in the literature, the changes in the thermodynamic potentials taking place during the formation of the phases in the Nb–O system, the solid solution of O in Nb, NbO, NbO_2, and Nb_2O_5 were plotted as a function of the composition. The ΔZ^0_{1273} values were as follows: NbO = 167.7; NbO_2 = 135.8; and Nb_2O_5 = 128.2 kcal/mol O_2. (TTT)

12679 REFRACTORY METALS IN NUCLEAR USES. John A. De Mastry. Battelle Tech. Rev., 12: No. 2, 3-8 (Feb. 1962).

Potential advantages of refractory metals in nuclear applications, as well as their limitations, are discussed. The metals, Nb, Mo, Re, Ta, W, and V, are considered. Topics covered include: technology, nuclear reactor materials requirements, general types of usage, reactor types suitable for refractory metals, current status, and outlook for continued applications. (M.C.G.)

12680 THE FRICTION AND WEAR OF ELECTROGRAPHITE. W. T. Clark, A. Connolly, and W. Hirst (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). Brit. J. Appl. Phys., 14: 20-7(Jan. 1963).

The structure, deformation, friction, and wear of an electrographite are investigated. A large proportion of this material consists of nearly spherical carbon-black particles, about 2000 Å in diameter, which have an "onion-like" structure with graphitic layers oriented parallel to the surface. The interlocking between the edges of adjacent graphitic regions is sufficient to destroy the plastic properties characteristic of true graphite. At the microscopic scale, the material is extremely hard, but the presence of porosity makes it macroscopically weak. It has an apparent Young's modulus of the order of 10^{10} c.g.s. units, but which depends on the previous history; indentation experiments using a $\frac{1}{2}$ in. steel ball show that it will recover almost completely from the large deformation caused by a load of 100 kg. There is no sharp yield point; failure is by brittle fracture. The coefficient of friction μ is measured in a crossed-cylinders apparatus; it is shown that the variation of μ with load is consistent with the supposition that the deformation at the contact is elastic. After repeated rubbing, soft films of wear debris are formed on the rubbed surfaces. These films are accompanied by a reduction of about 30% in μ. Electron micrographs of such films show that they contain carbon black particles and also their degradation products. Electron diffraction shows that the films sometimes contain graphitic planes oriented nearly parallel to the surface. The ability of a film to exhibit orientation depends on the relative proportions of carbon black particles and of the free layer planes formed by processes of degradation during wear. (auth)

12681 EFFECTS OF PROLONGED STRESS RELIEVING TREATMENTS ON THE MECHANICAL PROPERTIES OF REACTOR PRESSURE VESSEL STEELS. B. Watkins, D. S. Wood, and R. W. Nichols (Reactor Materials Lab., Culcheth, Lancs, Eng.). Brit. Welding J., 10: 37-53 (Feb. 1963).

The effect of the long stress relieving treatments given to reactor pressure vessels on the tensile, Charpy impact, creep and stress rupture properties of reactor quality, low-carbon, high-manganese, 28 tons/in.^{2} steels was investigated. A considerable number of casts were tested, including open-hearth Si-killed steel, open-hearth Al grain-refined steel, electric furnace steel, and weld metal. For all the plate materials, stress relieving at 600°C or above resulted in a fall in the yield point and U.T.S. of about 1 to 2 tons/in.^{2}; for the weld metal it was generally 3 tons/in.^{2} or more. Prolonged stress relieving resulted in an increase in the Charpy impact transition temperature of 10 to 20°C, even at stress relieving temperatures as low as 575°C. The impact properties of electric furnace steel did not generally deteriorate on stress relief, and often an improvement was observed. Weld metal impact properties showed considerable variability in response to stress relief. Prolonged stress relieving at 600°C caused a marked deterioration in the creep and rupture strength of Si-killed steel, but the creep strength of Al grain-refined steel was not significantly affected by stress relief. It is concluded that the deterioration in tensile and high-temperature properties can be minimized by limiting the maximum temperature and by careful control of the stress relieving cycle, but that the change in impact properties on stress relief must be taken into account even at stress relieving temperatures as low as 550 or 575°C. (auth)

12682 RELATIONS BETWEEN THE DEGREE OF ORIENTATION AND THE CONDITIONS OF THE DEPOSITION OF PYROLYTIC GRAPHITE. Tokichi Noda, Michio Inagaki, and Hajime Kato (Nagoya Univ., Japan). Bull. Chem. Soc. Japan, 35: 1471-4(Sept. 1962).

Pyrolytic graphites were deposited on carbon rods by the thermal decomposition of a commercial propane gas at various temperatures and at various rates of gas flow. The orientation functions of the graphite crystallites in the deposited graphites were measured by means of x-ray diffraction. It was shown that the degree of orientation in the deposited graphites increased with the increase in temperature of deposition and decreased with increase in the rate of gas flow. The graphites deposited at temperatures above 2000°C were composed of two layers; the inner layers had a larger degree of orientation and a higher graphitizability than the outer layers. Almost all the (001) diffraction profiles of the deposited graphites were found to be asymmetrical and to be apparently composed of two kinds of profiles, whose c_0 values were 6.72 and 6.86 Å. (P.C.H.)

12683 STRUCTURE OF FILMS OF THE ALLOY Al–Ag (25%) PREPARED BY A FUSION METHOD. Noboru Takahashi (Comitato Nazionale per le Ricerche Scientifique, Toulouse). Compt. Rend., 255: 2391-3(Nov. 5, 1962). (In French)

Thin films of the alloy Al–Ag (25%), to be used for electron microscopic examination, were prepared by a fusion method. Their structure was studied by microscopy and electron diffraction, and the results obtained are discussed. (tr-auth)

12684 INCREASE OF THE DUCTILITY OF URANIUM BY PARTIAL ANNEALING AFTER COLD WORKING. Nelly N. A. de Libanati and Sara V. de Tanis (Comision Nacional de Energia Atomica, Buenos Aires). Compt. Rend., 255: 2435-7(Nov. 5, 1962). (In French)

The partially recrystallized structures obtained by annealing at 350°C are much more ductile than those totally recrystallized in the α phase. The simultaneous presence of nonrecrystallized less deformed bands and of fine grained zones of the first steps of recrystallization is responsible for this behavior. In addition to the theoretical importance to the phenomenon, it facilitates the use of annealing temperatures much lower than those now used during the cold rolling of U. (tr-auth)

12685 PHASE STUDIES ON ARC-MELTED PLUTONIUM–CARBON ALLOYS NEAR THE MONOCARBIDE COMPOSITION. Owen L. Kruger (Argonne National Lab., Ill.). J. Am. Ceram. Soc., 46: 80-5(Feb. 1963).

The phase boundaries and structure of plutonium monocarbide were studied in arc-melted alloys containing between 42 and 60 at. % carbon. Metallographic and x-ray diffraction techniques were used to determine the phases present in as-cast and heat-treated alloys. The phase boundaries of cast PuC were found to be about 42.5 at. % carbon on the low-carbon side to between 48.5 and 50 at. % carbon on its high-carbon side. At 1000 and 400°C the low-carbon PuC phase boundary shifted to higher carbon compositions of about 45.5 and 46 at. % carbon, respectively. A comparison of the experimental densities with the theoretical densities showed that PuC was a defect structure with some of its carbon atom lattice sites vacated. (auth)

12686 DIELECTRIC PROPERTIES OF GLASSES IN THE SYSTEM Nb_2O_5–Na_2O–SiO_2. Chikara Hirayama and Daniel Berg (Westinghouse Research Labs., Pittsburg). J. Am. Ceram. Soc., 46: 85-8(Feb. 1963).

The effect of niobia on the dielectric properties of glasses in the system $Nb_2O_5-Na_2O-SiO_2$ was studied from 100 to 10^{10} cps. The dielectric constant is high even at frequencies up to 10^{10} cps. The Nb^{5+} ion, with its small ionic radius and high charge, reinforces the network and raises the dielectric constant. (auth)

12687 EXPERIMENTAL AND CALCULATED YOUNG'S MODULI OF ZIRCONIUM CARBIDE CONTAINING A DISPERSED PHASE OF GRAPHITE. D. P. H. Hasselman. J. Am. Ceram. Soc., 46: 103-4(Feb. 1963).

The modulus was measured experimentally for graphite dispersions in zirconium carbide, and the data are compared with the theoretical values derived respectively by Paul and Hashin for a matrix containing cubical and spherical inclusions. A plot of the modulus vs graphite content shows the experimental data to be in good agreement with Hashin's lower bound. (D.L.C.)

12688 INERT-ATMOSPHERE DILATOMETER FOR USE TO 2000°C. Peter T. B. Shaffer and Stanley D. Mark (Carborundum Co., Niagara Falls, N. Y.). J. Am. Ceram. Soc., 46: 104-6(Feb. 1963).

The dilatometer consists of a dense impervious SiC tube in which the specimen is supported in an inert atmosphere. A thin SiC rod extends from the top of the specimen to a micrometer dial on top of the tube. Temperatures are measured by Pt-Pt10Rh thermocouples to 1350 to 1400°C and by optical pyrometer at 1350 to 2000°C. Thermal expansion measurements to 2000°C are reported for SiC, TiC, MoC, ZrC, and 8TaC · ZrC. (D.L.C.)

12689 ON THE DEFECT STRUCTURE OF ZrO_2 AND HfO_2. P. Kofstad and D. J. Ruzicka (Central Inst. for Industrial Research, Oslo). J. Electrochem. Soc., 110: 181-4(Mar. 1963).

The defect structure of ZrO_2 and HfO_2 was studied through measurements of electrical conductivity as a function of oxygen pressure. The electrical conductivity exhibits an unusual and complex oxygen pressure dependence, and to explain the results it is proposed that these oxides are ionic conductors and that a coupled transport of oxygen vacancies and interstitials is faster than an independent transport of these defects. Thermogravimetric measurements on ZrO_2 suggest that the nonstoichiometry of this oxide is more than a factor of ten smaller than that observed by Aronson. (auth)

12690 AN ANALYSIS OF STRESS-INDUCED PERMANENT DIMENSIONAL CHANGES IN URANIUM FUEL BARS WITH A β-CORE. G. W. Greenwood and R. H. Johnson (Berkeley Nuclear Labs., Gloucester, Eng.). J. Nucl. Energy Pt. A and B, 16: 473-6(Oct. 1962).

It is shown that a pseudo-creep effect arises when small stresses act on uranium fuel bars that have a central β-core that varies in size. The pseudo-creep process is analyzed in detail and its magnitude is estimated. The effect is most severe when the β-core fluctuates about a critical radius and it can predominate over creep effects arising from thermal cycling of the α-phase. (auth)

12691 URANIUM MONOCARBIDE. G. A. Meerson, R. B. Kotel'nikov, and S. N. Bashlykov. J. Nucl. Energy Pt. A and B, 16: 485-8(Oct. 1962).

Uranium monocarbide is of interest as a possible nuclear fuel and as a material for nuclear thermoelectric conversion. To define more accurately the influence of the conditions of fabrication of uranium monocarbide on its constitution, experiments are undertaken, by means of which the optimum conditions for obtaining stoichiometric UC are defined. Investigation of the conditions of sintering and hot pressing of UC powder and also conditions for sintering alloys of UC + U results in a method of preparing specimens with a porosity of about 5 per cent. The specific gravity of UC powder determined with a pyknometer is 12.97 ± 0.09 g/cm^3, and the micro hardness is 923 ± 56 kg/mm^2. The thermal conductivity of UC in the range 100 to 700°C is found to be from 0.028 to 0.04 cal/cm/sec/°C; the mean thermal coefficient of linear expansion in the interval 20 to 1500°C is $11.6 \cdot 10^{-6}$. Specimens of UC thermally cycled in the range 200 to 1000°C withstood 500 cycles without disintegration. Specimens of UC + U withstand more than 1000 cycles. (auth)

12692 REFRACTORY GOOD TO 3600 F. Mater. Design Eng., 57: 82(Feb. 1963).

A description is given of the properties of Carborundum's Boride Z, a $ZrB_2-10\%$ $MoSi_2$ mixture which resists oxidation in air at temperatures up to 3600°F. Its oxidation resistance is due to its adherent, self-healing oxide film. It withstands thermal shock better than dense Al_2O_3 or ZrO_2 and is a conductor of electricity. (D.L.C.)

12693 ON THE INFLUENCE OF HYDROGEN ON THE CONSTITUTION AND THE MECHANICAL PROPERTIES OF NIOBIUM AND TIN CONTAINING ZIRCONIUM ALLOYS. W. Jung-Koenig, H. Richter, and U. Zwicker (Metallgesellschaft A. G., Frankfurt am Main). Metall, 17: 1-7(Jan. 1963). (In German)

In niobium-containing zirconium alloys the effects of hydrogen were stabilization of the β_H-phase and expansion of the β_H-field. By this means the formation of a martensitic transformation structure was promoted within the investigated concentration region. Coarse-needled hydride precipitates in alloys with about 3% niobium (and about 1% tin) appeared chiefly after cooling from temperatures above 700°C by return of the hydrogen solubility in β_H. By slow cooling the solution of hydrogen in α_H or β_{Nb} phases was possible, whereby no large hydride precipitates can appear. The plasticity was reduced by hydrogen, especially at room temperature. The influence on the expansion limit, the strength, and the time-stability behavior was differentiated by a simultaneous influence on solidification. Thus the expansion limits in niobium-containing zirconium alloys with very small permanent deformations were reduced by hydrogen. (tr-auth)

12694 THE FIRST SEMINAR OF THE DIVISION OF TECHNICAL SCIENCES OF THE UKRAINIAN ACADEMY OF SCIENCES ON SUPERFICIAL DIFFUSION SATURATION OF METALS. A. P. Epik. Metalloved. i Term. Obrabotka Metal., No. 12, 56-8(Dec. 1962). (In Russian)

A special meeting was held in Kiev in March 1962 for reviewing the problem of diffusion saturation of metals and of refractory coatings applied on metallic and nonmetallic objects. G. V. Zemskov described the methods used for enhancing the effects of chemical and thermal treatments by means of ultrasonic waves. Results indicated that the rate of nitride treatment is accelerated by this treatment; properties such as adherence and hardness of the protective layer were improved. G. N. Dubinin reviewed the complex diffusing layers of Fe-Cr-Si, Fe-Cr-Al, Fe-Al-Si, Cr-Al-Si, etc., applied on Mo and Nb by thermal diffusion saturation. The method offers good possibilities of protecting these metals against high-temperature oxidation. Yu. N. Gribeodov found that heat-treated electrodeposited Cr layers saturated with N possess increased wear, scratch, and corrosion resistance. The electrodeposition of the Cr layer on austenitic steels followed by a nitriding treatment found industrial application. A. P. Epik described the diffusion parameters in the case of boride and carbide

treatment of W and Mo in the solid phase; the diffusion rates of B and C into the base metal thickness of the protective layer were determined. (TTT)

12695 A CONTRIBUTION TO THE STUDY OF HIGH-MELTING SYSTEMS. STRUCTURE OF THE TERNARY SYSTEM: U–Zr–B AND MEASUREMENTS OF THE EXPANSION COEFFICIENTS OF $Mo_3(Al,Si)$, MoAlSi, $Mo(Al,Si)_2$ AND TaB_2. H. Holleck, F. Benesovsky, E. Laube, and H. Nowotny (Metallwerk Plansee, A. G., Reutte/Tyrol, Austria and Universität, Vienna). Monatsh. Chem., 93: 1075-9(Oct. 1962). (In German)

The structure of the ternary system U–Zr–B was studied by means of x-ray investigations. No ternary compounds are present, but UB_{12} and ZrB_{12} form a continuous mixed series. UB_2 dissolves about 10 mole % ZrB_2. The thermal expansion coefficients of TaB_2, MoAlSi, $Mo(Al,Si)_2$, and $Mo_3(Al,Si)$ were determined by measurement of the lattice parameters. (auth)

12696 BOND ENERGY OF VACANCIES AND INTERSTITIAL ATOMS IN GRAPHITE. R. L. Woolley (Central Electricity Generating Board, Gloucestershire, Eng.). Nature, 197: 66-7(Jan. 5, 1963).

The activation energy for the motion of a vacancy in graphite, the stored energy of a vacancy-interstitial pair, the activation energy to evaporate interstitial clusters, and the activation energy for diffusion of a singly bonded interstitial atom along the edge of the cluster are determined. Reactor temperatures associated with these energies are discussed. (D.C.W.)

12697 SOME PROPERTIES OF Al–20 wt. % U ALLOY IN ROLLED CONDITIONS. Ryukichi Nagasaki (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 4: 869-77(Dec. 1962). (In Japanese)

The effects of increasing quantities of hard brittle intermetallics on the rollability and hardness of alloys containing up to 20 wt. % U, with ternary additions of zirconium, silicon, tin, and titanium, are studied. The metallographic, x-ray, and hardness changes associated with the cold rolling are described. The alloys possess good rolling properties. The defect of cracking, however, develops slightly with 20 wt. % alloy, and is absent with alloys containing the ternary additional elements. During the later stages of cold rolling, some samples undergo considerable softening. Qualitative explanations are proposed to account for the observation on rolling softening. Softening occurs as a result of a recovery process in the aluminum phase; the intensified, localized deformation produced by turbulent plastic flow accounts for the softening effect in the aluminum component surrounding individual intermetallic compounds. (auth)

12698 THE EFFECTS OF THE RATE OF TENSION ON THE YIELD POINT OF ROLLED AND IRRADIATED POLYETHYLENE. Yoshinori Tsunekawa, Jobu Awatani, and Kohei Kojima (Osaka Univ.). Nippon Kikai Gakkai Rombunshu, 28: 559-64(Apr. 1962). (In Japanese)

Samples, 2-mm thick and having a density of 0.927 at 23°C, were prepared from Ziegler-type rolled polyethylene (nonirradiated) or by irradiation from a Co^{60} source under water, and then treated in boiling water for 1 hr for stabilization. The yield points were measured by means of an instron tester at cross-head speeds of 0.5, 3.0, and 20 cm/min at 30°C. The results showed that the yield point of polyethylene increased with increasing cross-head speed; however, its yield point ratio (the ratio of the yield point of the irradiated polyethylene to the yield point of the nonirradiated polyethylene) decreased when the tensile test was performed at higher speeds. (OID)

12699 SLIP DISTRIBUTION AND FRACTURE IN MAGNESIUM OXIDE. H. G. Tattersall and F. J. P. Clarke (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 7: 1977-94(Dec. 1962). (AERE-R-4104)

It is shown that as-cleaved magnesium oxide may go through several distinguishable stages of deformation prior to fracture. The exact mechanism of fracture depends on the stage at which it actually occurs. In all cases fracture occurs by a dislocation configuration, localizing strain energy near a sub-critical microcrack. This energy supplements the energy available from the overall elastic strain field during crack propagation, and so assists fracture. Particular dislocation configurations may be induced artificially by sprinkling an as-cleaved crystal surface with carborundum powder. (auth)

12700 PHASE TRANSFORMATIONS IN URANIUM AT HIGH PRESSURES. W. Klement, Jr., A. Jayaraman, and G. C. Kennedy (Univ. of California, Los Angeles). Phys. Rev., 129: 1971-5(Mar. 1, 1963).

The $\alpha-\beta$, $\beta-\gamma$ and the direct $\alpha-\gamma$ phase transformations in uranium have been studied up to 45 kbar at cooling and heating rates of 3–5°C/sec. The overheating and undercooling intervals for the $\alpha-\beta$ and $\beta-\gamma$ transformations at high pressures are about the same as the hystereses expected at zero pressure and do not vary appreciably with increasing contamination. Progressive contamination and resultant lowering of the transformation temperatures of the uranium samples were evident for all containers used, but was least for tantalum containers. The equilibrium $\alpha-\beta-\gamma$ triple point occurs at less than 31.5 kbar and greater than 803°C. The γ phase is definitely more compressible than the β phase and the β phase is probably more compressible than α. There is only a small hysteresis in the $\alpha-\gamma$ transformation. (auth)

12701 HOMOGENIZATION TREATMENT OF ALUMINUM–MAGNESIUM–SILICON ALLOY EXTRUSION BILLETS. R. Meillat and M. Croutzeilles (Compagnie Pechiney, Chambery, France). Rev. Met. (Paris), 59: 849-55(Oct. 1962). (In French)

Homogenizing improves the appearance and mechanical properties of the alloys and permits an increase in the extrusion rate. Results were obtained and tabulated for alloys with 0.50% Mg and 0.40% Si, 0.65% Mg and 0.50% Si, and 0.80% Mg and 0.60% Si. (auth)

12702 SURFACE TENSION OF MOLTED ALLOYS WITH MAXIMUM LIQUIDUS CURVES. V. N. Ermenko, V. I. Nizhenko, N. I. Levi, and B. B. Bogatyrenko (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Ukr. Khim. Zh., 28: 500-5(1962). (In Russian)

The surface tension and density of molted Ni–Al and Ni–Be alloys were studied at 1640 and 1500°C, respectively. Correlations were found between the appearance of tension-composition diagram and the constitution diagram. In the Ni–Be system the compound is inactive to both components, resulting in a maximum surface intensity isotherm. The data confirm that intermetallic molecular groupings are retained in molted metals. (R.V.J.)

12703 ELECTROGRAPHITE AS CONSTRUCTION MATERIAL FOR NUCLEAR REACTORS. Erich Nedopil. Umschau Wiss. Tech., 62: 696-7(Nov. 15, 1962). (In German)

The utilization of graphite as a moderator necessitates extreme purity. The properties of electrographite prepared from very pure starting materials and of graphite from

which the impurities are removed by halogen degassing at high temperatures are compared. The possible utilization of graphite as cladding material is also considered. (J.S.R.)

12704 SPECTRAL REFLECTANCE OF SOLIDS FOR BERYLLIUM K-RADIATION. George Leroy Johnson. Thesis, Stanford, Calif., Stanford Univ., 1962. 122p.

A vacuum x-ray reflectometer built to investigate the reflectance for Be K radiation of flat surfaces and evaporated films is described. A water-cooled target of Be bombarded by electrons is used as a source. Curves of reflectance vs grazing angle of incidence for Si and quartz flats and Al, Be, and Au evaporated films are presented. Good agreement between the observed critical angles and critical angles predicted by dispersion theory is obtained for Al, Au, and O where the critical absorption wavelengths of most of the electrons are well removed from the incident wavelength. The observed critical angles of Al and Au are 10 and 15% lower than theoretically calculated values, respectively. The observed critical angle of quartz is 3% lower than the value calculated using the observed critical angle of Si and the theoretical critical angle of O. A reduced reflector density may be the cause of the low critical angles observed. Where the critical absorption wavelengths are close to the incident wavelength for a large percentage of the electrons (Be and Si) agreement between observed critical angles and critical angles calculated using an oscillator density obtained from observed absorption coefficients is poor. Excluding Be, the absorption coefficients derived from the reflection curves average 8% lower than values obtained by standard techniques. (P.C.H.)

12705 THE FRENCH NUCLEAR GRAPHITE. Physical and Mechanical Characteristics. J. J. Baron (Pechiney Co., [France]). Preprint S5-08. Prepublication Copy. 11p.

The graphite used in France for the CEA reactors at Marcoule and the power reactors at Chinon is described, including its production, density, cross section, anisotropy, permeability, porosity, and mechanical characteristics. The methods used to measure the physical characteristics are also reported. The development of high-density graphite and impermeable graphite is briefly reviewed. (M.P.G.)

12706 CHARACTERISTICS OF THE OMEGA TRANSFORMATION IN ZIRCONIUM–NIOBIUM ALLOYS. Dante James Cometto. Thesis, Cleveland, Case Inst. of Tech., 1962. 85p.

Characteristics of the omega transformation in the Zr–Nb system were studied by single crystal x-ray diffraction techniques. Two distinct mechanisms for establishing a metastable equilibrium between beta and omega were investigated. The first mechanism involves diffusionless transformation of beta to omega on cooling from the beta field. The reaction was found to be continuously reversible with little or no hysteresis over a broad temperature range. The Lorentz expression for the shape of a pressure broadened line was found to fit the true line shape quite well if the power n of the distance from the line center was allowed to vary. For lines whose width at one-half their maximum per cent absorption was less than 2.2 cm^{-1}, n was found to be equal to 2. The value of n decreased for lines wider than the above to as low as 1.79 and had an average value of 1.85. In the range of pressures studied (1 cm to 5 atm pressure) n had no measurable dependence on pressure. Within experimental error, n was constant from the line center to at least 10 cm^{-1} from the line center for a particular line. Information on instrumental broadening corrections and line shape data is appended. (P.C.H.)

12707 SUPERCONDUCTING PROPERTIES OF PLASTICALLY DEFORMED ALUMINUM. William C. H. Joiner, IV. Thesis, New Brunswick, N. J., Rutgers Univ., 1962. 115p.

The effects of plastic deformation on the superconducting transition temperature, T_c, and on the residual electric resistivity, ρ, of pure Al were determined. Specimens were filed, cold rolled 97%, fatigued, and deformed in uniaxial tension at room temperature. In all cases where a change in T_c was observable, the transition point decreased. The rate of decrease with resistivity and the change in T_c of a quenched specimen subsequently aged at room temperature were consistent with other observations. Isochronal annealing of the rolled specimens showed that T_c and ρ could be restored to the values for undeformed specimens. The annealing produced the greatest changes in the temperature interval 180 to 300°C. Since recovery in Al occurred rapidly in the same temperature interval, this confirmed that the changes in T_c produced by deformation are associated with the resistivity of dislocations. Cold rolled impure specimens were also measured. Specimens with small impurity resistivity showed an incremental decrease of T_c resulting from the increase in residual resistivity due to dislocations, whereas specimens of high impurity resistivity showed an increase of T_c. The effects seemed to be independent of impurity type, and the sign of the incremental transition temperature change reversed at an electron mean free path about equal to the range of coherence. Dislocations in cold-drawn wires produced a temperature hysteresis in the transition curves. The hysteresis effect is discussed in terms of the more familiar type of field supercooling observed in very pure, annealed specimens. (P.C.H.)

12708 DIFFUSION COEFFICIENTS OF THE ZIRCONIUM–HYDROGEN SYSTEM. Vincent Lucian Gelezunas. Thesis, Cincinnati, Ohio, Univ. of Cincinnati, 1962. 149p.

The sorption of pure hydrogen by high-purity Zr was determined as a function of time by the use of experimental techniques capable of following the reaction to equilibrium at a constant temperature and hydrogen pressure. The Zr was in the form of cylinders and spheres. The experimental hydrogen sorption curves, obtained from Zr which contained 0.3 at. % oxygen in the as-machined condition, agreed with theoretical curves, which were based on Fick's second law and on the assumption that the surface of Zr offered a negligible resistance to hydrogen as compared to the bulk diffusion resistance. The diffusion coefficients for the beta phase of the Zr–H system were calculated from the hydrogen sorption curves. The calculated diffusion coefficients of hydrogen in beta Zr were expressed as: $D = 5.32 \times 10^{-3} \exp(-8320/RT)$ cm^2/sec (760–1010°C). The diffusion coefficients for hydrogen were found to be independent of hydrogen concentration in Zr for hydrogen concentrations of up to 41 at. % hydrogen. Further hydrogen sorption experiments were carried out with Zr which contained 1.0, 2.1, and 4.2 at. % oxygen in solid solution with the Zr. A departure from the theoretical hydrogen sorption curves was observed in the form of a decreased rate of hydrogen sorption: the rate decreased with an increased oxygen content in the Zr. However, if the Zr, which contained oxygen, also contained sufficient hydrogen so that the Zr existed in the beta phase, then no effect was observed, and the hydrogen sorption curves agreed with the theoretical curves. This result suggested that the diffusion coefficients for hydrogen in beta Zr were independent of oxygen content in beta Zr in the range of 0.3 to 4.2 at. % oxygen. An investigation was also made of the effect of various surface films on the sorption of hydrogen by Zr, which contained 0.3 at. % oxygen in solid solution.

Of the films studied, the chemical film was found to be the most resistant to hydrogen penetration, and the most difficult to remove. (P.C.H.)

12709 PROBLEMA REDKIKH ZEMEL. (The Problems of Rare Earths). D. N. Trifonov. Moscow, Gosatomizdat, 1962. 221p.

A survey is given of the isotopic content, properties, and uses of rare earths. A special chapter is dedicated to promethium. (R.V.J.)

Radiation Effects

Refer also to abstract 13728.

12710 (AD-277814) EFFECTS OF NUCLEAR RADIATION ON QUARTZ CRYSTAL UNITS. Report No. 3. Second Quarterly Progress Report, November 23, 1961 through February 22, 1962. B. Gerstein, A. Schlueter, and A. Fueyo (Admiral Corp., Chicago). Mar. 30, 1962. Contract DA 36-039-sc-85322. 150p.

Designs of quartz crystal units were evaluated in the environment of a linear accelerator for fast neutron, gamma, and electron doses and in a cyclotron for neutrons and protons. In addition, recommendations for improved materials and fabrication techniques are made, and such modified quartz crystal units will be irradiated in a Godiva environment. (auth)

12711 (ANL-FGF-399) PRELIMINARY IRRADIATIONS OF PuC AND UC–PuC. J. H. Kittel, R. Carlander, L. A. Neimark, O. L. Kruger, and R. C. Lied (Argonne National Lab., Ill.). Nov. 1962. Contract [W-31-109-eng-38]. 6p. (UAC-7022)

The C content of the specimens used in the irradiations ranged from 4.75 to 5.73%. The Pu content of the mixed carbide specimens was varied from 17.2 to 27.8%. Results are presented of tests in which PuC and mixed carbide specimens were irradiated to burnups ranging from 500 to 770 Mwd/mt at central temperatures ranging from 370 to 650°C. Pressed and sintered pellets of mixed carbide were irradiated to burnups ranging from 54 to 810 Mwd/mt and central fuel temperatures at 260 to 380°C. (J.R.D.)

12712 (BMI-1609) EFFECTS OF LARGE NEUTRON DOSES AND ELEVATED TEMPERATURE ON TYPE 347 STAINLESS. William E. Murr, Frederic R. Shober, Robert Lieberman, and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Jan. 21, 1963. Contract W-7405-eng-92. 53p.

Tests of subsize tensile and impact specimens of Type 347 stainless steel irradiated in three capsules to fast-neutron exposures of up to 1.1×10^{22} nvt were conducted. Ductile fractures at impact energies of 65 ft-lb, representing a 35% decrease in impact strength, were noted at room temperature. Impact energies of ~20 ft-lb and a fracture with both brittle and ductile characteristics were observed at −300°F. Irradiation-induced property changes included increases in yield strength from 35,000 to 105,000 psi and in ultimate strength from 90,000 to 112,000 psi and a decrease in total elongation from 63 to 31% at room temperature. A 600°F anneal produced no measurable recovery of preirradiation properties for periods up to 144 hr, but a large degree of recovery was obtained by annealing 1 hr at 1800°F. In material irradiated at 750°F, increases in yield strength from 55,000 to 149,000 psi and in ultimate strength from 92,000 to 149,000 psi, decreases in elongation from 55 to 10%, and reductions in area from 70 to 60% were observed. (H.G.G.)

12713 (BMI-1613) INITIAL IRRADIATION EVALUATION OF EXPERIMENTAL Al_2O_3-COATED UO_2 FUEL PARTICLES. Neil E. Miller, Robert L. Ritzman, Richard J. Burian, and Charles W. Townley (Battelle Memorial Inst., Columbus, Ohio). Jan. 30, 1963. Contract W-7405-eng-92. 32p.

The in-pile behavior of Al-coated UO_2 particles was studied at 100 to 1070°C and to fuel burnups of about 5 at. % of the U^{235}. At 1070°C the particles exhibited excellent integrity and showed essentially complete fission-product retention to 3 to 4 at. % burnup of the fuel. Similar exemplory behavior was not found at 100°C where samples failed rapidly, failure being essentially complete in a few hours. Studies carried out at intermediate temperatures indicated that the low-temperature failure occurred only at temperatures below about 500°C. It was postulated that the failure was a result of radiation damage to the alumina coatings, caused by bombardment of the interior surface of the coatings with fission recoils, and that no failure occurred above 500°C because sufficient annealing of the damage above this temperature took place. The in-pile studies were performed on both unsupported particles and particles supported in graphite or C matrices. Specimen performance was also evaluated by postirradiation examinations including fission-gas-release measurements, determination of the fraction of exposed U, and visual and metallographic examinations. (auth)

12714 (BNL-745) FUNDAMENTAL STUDIES OF RADIATION DAMAGE IN GRAPHITE. Donald G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). Apr. 17, 1962. Contract [AT(30-2)-Gen-16]. 16p. (BNL-T-270). Brookhaven Lecture Series No. 16.

Graphite expands linearly with irradiation at temperatures below 250°C and develops stored energy of the lattice because of interstitial and vacancy defects. Radiation changes such as stored energy and dimensional expansions can be removed by thermal annealing in which the graphite is removed from the radiation field and heated to a temperature above the irradiation temperature. The thermal annealing of irradiated graphites shows that the greater the irradiation dose, the greater is the recovery obtained at a given temperature. In periodically irradiated graphites, the 200°C stored energy no longer increases as it does in continuously irradiated graphites. Thermal annealing not only removes radiation damage but redistributes and creates it. (H.G.G.)

12715 (GEAP-3983) SLOW CYCLE STRAIN FATIGUE IN THIN WALL TUBING: PRELIMINARY REPORT. M. B. Reynolds (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 19, 1962. Contract AT(04-3)-189.

A technique has been developed for slow cycle strain fatigue testing using specimens of thin-wall tubing of the type under consideration for use as super heat fuel cladding. Data on type 304 stainless steel have been obtained under radiation and in the absence of radiation. The strain cycle fatigue life of this alloy at 1200 to 1300°F is decreased three fold by the presence of a neutron flux of $1.5 \times 10^{14} > 1$ Mev. Out-of-reactor data have been obtained on Inconel at 1300°F. (auth)

12716 (GEAP-4137) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Fourth Quarterly Progress Report, September–November 1962. B. F. Rider, C. P. Ruiz, and J. P. Peterson, Jr. (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Dec. 1, 1962. Contract AT(04-3)-189. 29p.

Work continued on the development of procedures for ac-

curate nuclear fuel burnup analysis. The analysis of three fuel samples as a function of radius shows that fission products including Cs, Sr, Ce, and Zr can migrate in an oxide fuel. This could be a source of error in any burnup analysis based on a highly localized fission product-to-U ratio unless the fission product selected does not migrate. Each of the four fission products measured has a gaseous precursor. Upon completion of the Nd separation scheme development, the same samples will be analyzed for Nd to determine whether the lack of gaseous precursors in the heavy Nd fission product isotopes will help overcome this fission product migration problem. A chemical separation scheme for Nd was developed. It consists of three major steps including the removal of bulk U from 12M HCl solution on a Dowex-2 column, the separation of Nd from rare and alkaline earths by extraction with di(2-ethylhexyl)phosphoric acid in hexane, and the removal of anionic impurities and soluble organic residues on a Dowex-50 column. Parallel work on reversed phase partition chromatography of Nd on columns of di(2-ethylhexyl)phosphoric acid supported on VYNS is scheduled for incorporation into the separations scheme in place of the solvent extraction step resulting in an all-column process. (auth)

12717 (HW-62422) EFFECT OF IRRADIATION UPON MECHANICAL PROPERTIES OF ZIRCALOY-2. A. L. Bement and D. L. Gray (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 4, 1959. Contract AT(45-1)-1350. 8p.

The results of the investigations described indicate that little if any recovery of neutron damage to the tensile properties of Zircaloy-2 occurs in the temperature range from room temperature to 280°C. Within this temperature range and for exposures to 10^{21} fast nvt, a relatively large increase in yield strength can be expected. This is accompanied by a marked decrease in the ability of Zircaloy-2 to strain harden which is manifested by the approach of the yield strength to the ultimate strength. Under such conditions, any overstressing of a structural member beyond the yield strength would result in nonuniform yielding leading to fracture. This consideration is important for pressurized tubing designed for long term service in a neutron environment. For a fuel element having the jacket bonded to the stressing member, the amount of uniform elongation in the jacket material is an index of the amount of plastic strain that can occur without failure. The uniform elongation of annealed Zircaloy-2 is reduced from approximately 25 to 12 per cent by irradiation to 10^{21} nvt. While this change is large, the amount remaining provides for a moderate amount of plastic strain. (auth)

12718 (HW-67949(Rev.)) EVALUATION OF PROPERTIES OF IRRADIATED ZIRCALOY-2 PRESSURE TUBE FROM KER LOOP 1. L. J. Defferding (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1962. Contract AT(45-1)-1350. 23p.

A destructive examination was made of a Zircaloy-2 pressure tube that had been in service for 600 days, KER Loop 1, for the testing of fuel elements. Metallographic examination revealed a low percentage of recrystallization for about 90% of the tube wall thickness and very large grains at the outer surface. Room temperature burst tests indicate that the tube was capable of withstanding the operating pressure and temperature of the loop. The total reactor environment produced an increase of 17% in the ultimate strength of the tubes over the unirradiated tubing. No apparent effect of location on the bursting strength of the test section was observed. The hydrogen concentration was ~1000 ppm at the inner surface and diminished to ~50 ppm at the outer surface of the tube. (H.G.G.)

12719 (N62-12598) RADIATION EFFECTS OF 40 AND 440 Mev PROTONS ON TRANSISTORS. William C. Hulten (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). [1962]. 42p.

Experimental results are presented covering the data collected before, during, and after the bombardment of several types of transistors with 40 and 440 Mev protons. The data indicate a proton energy, as well as a transistor frequency dependence on degradation of the various parameters measured. A number of figures are presented showing the degradation of the gain of the transistors as a function of integrated proton flux. (auth)

12720 (NP-12501) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 7, July 1962 through September 1962. (Lockheed-Georgia Co., Marietta, Ga.). Contract NASw-114. 53p. (ER-6047)

A summary of temperature-measuring techniques for use with specimens undergoing irradiation and testing at 30 to 540°R is presented. A method of temperature control is being developed by which the specimen temperature is controlled by controlling the temperature of a surrounding gas. Methods of establishing relations between the gas and specimen temperatures are discussed. A thermocouple-measurement program to develop techniques for use at Plum Brook is reported. Studies are described concerning thermocouple wire selection, thermocouple calibration, and measurement of temperature gradients in test specimens without irradiation. Fabrication of shielding for beam port test loops, and remote handling equipment are described. Installation of a sample change transfer system, and a refrigeration system at Plum Brook is reported. Design of a fission chamber and calorimeter to continuously monitor the fast neutron flux and gamma dose rate at specimen irradiation positions is in progress. (J.R.D.)

12721 (OEL-Nuclear-56) IRRADIATION TEST ON ELECTRICAL AND MECHANICAL COMPONENTS FOR A GAUGING SYSTEM FOR REACTOR PRESSURE TUBES. H. P. Koehler and J. Pefhany (Roe (A. V.) Canada Ltd. Orenda Engines Div., Malton, Ont.). Oct. 1962. For Atomic Energy of Canada Ltd., Chalk River, Ont. 35p. (AECL-1627)

Irradiation test work during shutdowns of NRX Reactor for the development of components for the gauging system for reactor pressure tubes is described. Indications of satisfactory operation of the basic system have been obtained. Further development and proving of a few of these is desirable and a program of further test work is outlined. (auth)

12722 (TID-17839) FAST NEUTRON DOSIMETRY FOR RADIATION DAMAGE STUDIES. A. David Rossin and Roland J. Armani (Argonne National Lab., Ill.). Nov. 1962. Contract [W-31-109-eng-38]. 13p. (SM-36/86; UAC-7026)

Accurate determination of fast neutron exposure for radiation damage studies requires knowledge of the fast neutron spectrum. The shape of this spectrum can differ appreciably between a test reactor and a power reactor pressure vessel wall. The use of a single threshold-type activation foil is limited because of these spectral variations, since the energies of most of the neutrons usually lie below the activation threshold. If the spectral shape is known, one foil is sufficient to establish the magnitude. Activation ratios of various foils can check the shape of the spectrum. Reactor neutron spectra have been calculated at locations of interest using multigroup reactor physics techniques. Then foils and specimens for damage

studies were irradiated at such locations. This paper compares calculated and measured activation rates in four vastly different reactor environments. Cross section values are constructed for use in these activation calculations and their effective values in a pure fission spectrum are computed. (auth)

12723 (TID-17933) METHODS OF PREDICTING THE PERFORMANCE OF SEMICONDUCTOR ELECTRONIC CIRCUITS AND SYSTEMS IN A NUCLEAR ENVIRONMENT. S. C. Rogers (Sandia Corp., Albuquerque, N. Mex.). [Jan. 1963]. Contract [AT(29-1)-789]. 34p. (SCDC-3045)

Increased use of semiconductor devices in nuclear environments necessitates an understanding of performance changes due to radiation. Analytical methods involving equations describing component and circuit performance as a function of radiation and experimental methods based either on observance of the performance of pre-irradiated components in a circuit or on actual irradiation of the circuit can determine failure levels and probabilities. Advantages and disadvantages of the methods are discussed as are the actual effects and mechanisms of radiation damage. Estimation of system failure levels, significance of surface effects, and design techniques for minimizing radiation effects are also treated. Variations of initial outputs of components make prediction of failures more difficult and demand high quality control. (D.C.W.)

12724 THERMO-ELECTROMOTIVE FORCE OF VANADIUM PENTOXIDE EXPOSED TO THE ACTION OF NUCLEAR RADIATIONS. I. Maxim and L. Rîbco (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 289-95(1962). (In Rumanian)

The variation of the thermo-electromotive force of V_2O_5 both during and after reactor irradiation was studied. During irradiation with a flux of 5×10^{12} n/sec cm^2 and a gamma dose of 10^4 r/sec, the thermo-electromotive force begins to increase, reaches a maximum value after 4 to 5 hrs of irradiation, and then returns to its initial value. After irradiation, the thermo-electromotive force keeps the same value as before irradiation. (tr-auth)

12725 OCCURRENCE OF CURRENTS IN DIELECTRICS UNDER γ IRRADIATION. B. M. Vul (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung., 14: 225-9 (1962). (In German)

The occurrence of electric currents in dielectrics under γ irradiation can be simply described with the help of the assumption that free electrons were produced exclusively by γ irradiation. The decrease in the number of electrons is connected with their recombination with ions, which is explained by the fact that the electrons were captured in the vacancies. (tr-auth)

12726 THE EFFECT OF CHANNELING ON DISPLACEMENT CASCADE THEORY. Ordean S. Oen and Mark T. Robinson (Oak Ridge National Lab., Tenn.). Appl. Phys. Letters, 2: 83-5(Feb. 15, 1963).

It is shown that channeling of energetic atoms in crystal lattices may be very important in determining the total number of displaced atoms in a cascade. (C.E.S.)

12727 EFFECTS OF γ-RAY IRRADIATION ON CARBON RESISTORS. T. Nakai and T. Sakakibara. Electrotech. J. Japan, 6: No. 2, (1961). (In English)

The effects of Co^{60} γ radiation on the electric characteristics of carbon resistors are explained and the causes of these phenomena are discussed. (auth)

12728 THE PREDICTION OF IRRADIATION GROWTH RATES IN URANIUM BY RESISTIVITY AND EXPANSION MEASUREMENTS. B. Pawelski and J. J. Stobo (C. A. Parsons and Co. Ltd., Newcastle-upon-Tyne, Eng.). J. Nucl. Energy Pt. A and B, 16: 477-81(Oct. 1962).

Thermal expansion and resistivity are measured on longitudinal specimens from core and rim positions in uranium fuel bars. The measurements are used to predict the irradiation growth rates at these positions as percentages of the growth rate of a single crystal; the assumptions necessary to make these predictions are explained and justified. While errors of the order ±20 per cent are expected in the absolute prediction of growth rate, comparisons between specimens can give relative growth rates within ±4.8 per cent of the single crystal growth rate. The cores of the uranium bars examined are expected to shrink on irradiation relative to the rims at rates between 3.5 and 14.1 per cent of the single crystal growth rate. (auth)

12729 ELECTRON SPIN RESONANCE IN ELECTRON-IRRADIATED DIAMOND. E. A. Faulkner and Jenifer N. Lomer (Univ. of Reading, Berks, Eng.). Phil. Mag. (8), 7: 1995-2002(Dec. 1962).

The room temperature electron spin resonance spectrum of diamonds irradiated by 2-Mev electrons is measured at a frequency of 9.5 kMc. The spectrum is analyzed into four systems, all of which show a g value within 0.2% of the free-spin value, namely: a single isotropic line with a width of about 5 gauss; an anisotropic system of up to 24 lines of width about 5 gauss, with a maximum splitting of ±1.5 kgauss and symmetry axes near to the (221) directions; an anisotropic system of up to 6 lines of width 25 to 50 gauss with a maximum splitting of ±1.5 kgauss and symmetry axes along the (100) directions; and a broad absorption with a complicated anisotropic structure, showing a maximum splitting of ±150 gauss. It is suggested that the centers giving rise to the second and third of these systems consist of two localized components, and that the splitting arises from magnetic dipolar interaction between them. The geometry of the axes can be explained if it is assumed that one of the components is a double defect such as a di-interstitial with the spin acting as if localized at its center. The fourth system is interpreted as arising from vacancy-interstitial pairs of various separations and orientations. (auth)

12730 EVIDENCE FOR HEATED SPIKES IN BOMBARDED GOLD FROM THE ENERGY SPECTRUM OF ATOMS EJECTED BY 43 Kev A^+ AND Xe^+ IONS. M. W. Thompson and R. S. Nelson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 7: 2015-26(Dec. 1962). (AERE-R-3995)

A low-energy peak at 0.15 ev is observed in the energy spectrum of atoms ejected from Au under heavy ion bombardment. The peak accounts for 12% of all atoms sputtered in the case of 43-kev Xe^+ ions, and 4% with 42.5-kev Ar^+ ions. It is shown that the phenomenon is not directly associated with focused collision sequences, and an explanation is given in terms of evaporation from heated spike regions. A deduction that the focusing range is much greater than the recoil atom's range leads to a model of constant radius spikes. The ensuing calculation correctly predicts the shape of the spectrum, its magnitude and its dependence on the bombarding ion. An effective radius of 110 Å and a maximum temperature of 1750°K are deduced for spikes caused by recoils with 42 kev. Some implications are considered in the fields of radiation damage and sputtering. (auth)

12731 THE GROWTH OF DISLOCATION LOOPS DURING THE IRRADIATION OF ALUMINUM. K. H. Westmacott, A. C. Roberts, and R. S. Barnes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 7: 2035-49(Dec. 1962). (AERE-R-4096)

Thin films of zone-refined aluminum are bombarded at 80°C with a flux of 1.6×10^{10} fission fragments cm^{-2} sec^{-1} for various times. Defects can be discerned after 30 sec when the films are viewed in the electron microscope, and after longer times the defects enlarge into dislocation loops. The larger loops lie near {110} planes with ⟨110⟩ Burgers vectors. The configuration of the loops and their behavior on heating suggest that they migrate by a combined conservative climb and slip process. At the higher doses, loops lie within the larger loops and the diffraction contrast behavior suggests that these loops have opposite Burgers vectors, i.e., a vacancy loop is encompassed by an interstitial loop and vice versa. In cases where two loops combine the dislocation interactions confirm this hypothesis. It is concluded that both vacancy clusters and interstitial clusters form during the bombardment and that initially each type attracts its own kind and repels the other so that each grows almost independently by a process involving both conservative climb and slip. As they enlarge slip becomes the more important process, and near-by loops of the opposite kind lying on similar slip cylinders slip together, partially cancelling one another. The slip and climb processes are compared, using a simple example where circular prismatic edge dislocation loops interact in aluminum, and found to be compatible with the interpretation. Some implications of the behavior are given. (auth)

12732 DIRECT OBSERVATIONS OF NEUTRON IRRADIATION DAMAGE IN α-IRON. B. L. Eyre (Berkeley Nuclear Labs., Gloucestershire, Eng.). Phil. Mag. (8), 7: 2107-13(Dec. 1962).

Transmission electron microscopy is used to observe damage in α-Fe foils, following irradiation of the foils to total doses of 5×10^{17} to 1×10^{19} neutrons/cm^2 (neutron energy above 1 Mev). The irradiations are carried out at 60°C. The irradiation damage can be observed directly, in the form of fine black spots, at the highest dose. The extent of the damage can be inferred at the lower doses, however, by observing dislocation production and movement in unirradiated and irradiated samples. (T.F.H.)

12733 REMARKS ON THE CASCADE THEORY FOR THE CALCULATION OF THE NUMBER OF RADIATION DEFECTS IN SOLIDS. O. Hauser and M. Balarin (Zentral institut für Kernphysik, Rossendorf, Ger.). Phys. Status Solidi, 2: 1471-8(1962). (In German)

Various derivations for the number of radioinduced defects were compared within the framework of the cascade theory. The energy loss of an atom shifted in the solid and its effect on the number of defects produced were followed step by step and discussed. The assumptions and limitations of the cascade model were critically evaluated. A comparison was made between the experimentally and theoretically determined number of defects using irradiation studies on copper. (tr-auth)

12734 THE THERMOLUMINESCENCE OF IRRADIATED POLYETHYLENE AND OTHER POLYMERS. A. Charlesby and R. H. Partridge (Royal Military Coll. of Science, Shrivenham, Wiltshire, Eng.). Proc. Roy. Soc. (London), Ser. A, 271: 170-87(Jan. 15, 1963).

The thermoluminescence glow curves of various polymers were observed in the temperature range 77°K to ice point after Co^{60} γ-irradiation, and a number of them are reproduced. A detailed study of polyethylene thermoluminescence was made. The glow curve of this material in the absence of oxygen comprises three glow peaks, the α, β, γ peaks, whose luminescence intensities are proportional to irradiation dose for doses below 50 krads. The α, β, γ peaks all decay exponentially at constant temperature, and a study of the kinetics involved shows that all these peaks have the same activation energy at the lowest temperatures. At higher temperatures the β and γ peaks each show two different transition points, one in the visible region and one in the ultra-violet, which appear to be related to two of the known structural transitions of polyethylene. The glow curves of a variety of different polyethylenes were recorded. By comparison of these it was found that the relative heights of the α, β, γ peaks are dependent on the degree of crystallinity of the materials but that the normal chemical impurities present in commercial polyethylenes have no effect on their glow curves. (auth)

12735 THE EFFECT OF OXYGEN ON THE THERMOLUMINESCENCE OF IRRADIATED POLYETHYLENE. A. Charlesby and R. H. Partridge (Royal Military Coll. of Science, Shrivenham, Wiltshire, Eng.). Proc. Roy. Soc. (London), Ser. A, 271: 188-206(Jan. 15, 1963).

The main thermoluminescence glow curve, the α, β, γ glow curve, of polyethylene irradiated by γ rays at 77°K was found to be greatly affected by molecular oxygen absorbed in the material before irradiation. The oxygen removes the β and γ peaks almost entirely at low irradiation doses and adds another peak, the ϵ peak, at a lower temperature than these to form an α, ϵ glow curve. Kinetic studies showed that the ϵ peak has a higher probability constant at low temperatures than any of the α, β, γ peaks but that it shares the same common activation energy. Since the ϵ luminescence cannot be observed at 77°K it seems that some change, perhaps a structural change, must occur during warming from 77°K before it can begin to appear. The oxygen effect can be removed by pumping or by a preirradiation followed by preheating. The latter method is shown to remove the oxygen by conversion into peroxide radicals, produced when the oxygen combines with alkyl radicals formed during the preirradiation. The ϵ peak was found to occur only in the presence of oxygen molecules, but not with oxygen in the form of peroxides. Peroxide radical formation was observed by means of the electron spin resonance (e.s.r.) method. E.s.r. measurements also showed that thermoluminescence in polymers was not a direct product of free radical reactions. Various possible thermoluminescence mechanisms are discussed and it is shown that the polyethylene thermoluminescence phenomena can be explained on the basis of a model involving the trapping of electrons followed by their recombination with different types of luminescence centers. (auth)

12736 IRRADIATION OF DIAMOND SEMICONDUCTORS. P. J. Kemmey (Diamond Research Lab., Johannesburg). Rev. Gen. Electron., 16: 25-8(Nov. 1962). (In French)

Results are presented for electrical measurements made on irradiated diamonds of the semiconductor type. The irradiations were carried out using electrons or neutrons of sufficient energy to displace the C atoms from their normal positions in the crystalline system. (D.L.C.)

12737 THE EFFECT OF EXPOSURE TO THE RADIATION OF THE INSTITUTE FOR ATOMIC PHYSICS REACTOR ON THE MAGNETIC PROPERTIES OF SOME FERRITES USED IN AUTOMATIC DEVICES. N. Andreescu and K. Motoc (Inst. for Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 7: 183-91(1962). (In Russian)

Literature data indicate that the magnetic properties of various materials are differently affected by γ radiation; Ni ferrites and Si–Fe alloys are hardly affected and may be used for the construction of devices exposed to radiation while the properties of Mo Permalloy and others are

greatly influenced. This problem was further studied exposing ferrites having a rectangular hysteresis loop of high magnetic permeability, prepared from complex core materials containing Fe_2O_3; ZnO; and Ni, Mg, or Mn oxides, to the neutron flux of the Institute's reactor. First tests with an integral flux of 4.3×10^{17} n/cm^2 resulted in insignificant changes in the properties; the exposures were therefore extended to integrated fluxes of 1.7×10^{18} and 2.8×10^{18} n/cm^2. The results showed that the limiting hysteresis loop changed only slightly, if at all; on the other hand the magnetic permeability decreased by 20 to 30%. It is assumed that exposure to such neutron fluxes results in changes of the ferrite grain structure; this may be due to dislocations or major crystal defects or may be caused by disturbances in the homogeneous character of the material by precipitation of certain phases. (TTT)

12738 SELF-DIFFUSION IN LEAD UNDER IRRADIATION WITH α PARTICLES. W. Biermann and D. Heitkamp (Universität, Göttingen, Ger.). Z. Physik. Chem. (Frankfurt), 34: 265-8(Sept. 1962). (In German)

The effect of α irradiation on self-diffusion in lead was studied at such temperatures that the radioinduced defects are sufficiently mobile to be measurable. The strong absorption of the α recoil beams was used for the determination of the diffusion velocity. The results showed that an exact determination of the diffusion under α irradiation was not possible as the surface of the diffusion probe was often chemically altered. However, it was determined that the increased diffusion velocity observed for short-time irradiation decreased with time. (J.S.R.)

12739 COATED PARTICLE FUELS DEVELOPMENT AT GENERAL ATOMIC FOR THE PERIOD MAY–OCTOBER 1962. Walter V. Goeddel (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 25, 1962. Contracts AT(04-3)-314 and AT(04-3)-167. 14p. (GA-3620)

To be published in TID-7654 proceedings of the Battelle Symposium on Coated Particle Fuels, Columbus, Ohio, June–July 1962.

Data and information obtained in post-irradiation examination of Peach Bottom Reactor fuel compacts tested in the General Atomic In-pile Loop (GAIL) are presented. Other information is included on thermal compatability of pyrolytic carbon-coated particles of thorium–uranium carbides. (J.R.D.)

12740 REACTOR RADIATION EFFECTS ON GRAPHITE. P. Leveque. Preprint S5-09. Prepublication Copy. 12p.

The effects of epithermal and fast neutron bombardment of graphite include the stored energy or Wigner effect, changes in thermal conductivity, dimensional variations, changes in mechanical properties, and variations in the crystalline parameter and electrical resistivity. These effects are briefly described. The reactions of graphite with air and CO_2 are also reviewed. Figures are referred to but are not included in the preprint. (M.P.G.)

12741 THE SOLID STATE GAMMA IRRADIATION OF CRYSTALLINE AMINO ACIDS AND SUGARS. Sanford S. Jacobs. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 105p.

A kilocurie Cs^{137} source was designed and constructed to facilitate the study of a wide range of problems in radiation chemistry. The source was divided into high- and low-level radiation areas. The compact high-level radiation volume was designed to have a radiation intensity of 500000 rads/hr in order to study the radiation chemistry of chemical compounds, and the low level area with an intensity of 1000 to 3000 rads/hr enables an examination of the effects of radiation on laboratory animals, plants, and fairly large liquid volumes to be conducted. The interests of safety were strongly stressed in the construction of the source. The infrared spectra between 5 and 8 microns of L-cysteine, DL-serine, L-glutamic acid, and glycine in a pressed KBr pellet were examined quantitatively using a base-line optical density technique. Amino acids irradiated in the solid state were examined in the same manner, and the changes due to irradiation were calculated from a comparison with the empirical calibration curves. All the bands studied for glycine and glutamic acid showed an initial increase in relative intensity after irradiation. The methylene vibration in serine exhibited the same unusual effect. In contrast to this increase, all the bands studied in cysteine and the $-COO^-$ and $-NH_3^+$ vibrations in serine showed the expected decrease with dose. G(–M) values were determined for glucose and fructose by two different methods. The loss of crystalline glucose during irradiation, as determined by an isotope dilution technique, was found to be 5.4 molecules/100 ev. G(–M) values determined for crystalline glucose and fructose by direct chemical analysis were 5.4 and 3.6. (P.C.H.)

12742 THE INFLUENCE OF INCORPORATED RADIOACTIVITY AND EXTERNAL RADIATION ON THE DEHYDRATION OF CYCLOHEXANOL OVER SULFATE CATALYSTS. Norman Albert Krohn. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1962. 149p.

The vapor phase dehydration of cyclohexanol on magnesium sulfate and magnesium sulfate–sodium sulfate catalysts was studied. The effects of the incorporation of radioactive S into the sulfate radical, x irradiation of the catalyst while in use, and preirradiation with gamma rays were investigated. It was concluded that the reported enhancements of catalytic activity by the addition of radioactive S are erroneous. When compared on a unit surface area basis, the radioactive catalysts were found to be less active than nonradioactive catalysts of the same composition. The erroneous reports may be attributed to the fact that for a given heat treatment, the radioactive catalysts have larger surface areas than their nonradioactive counterparts. The crystallite size of the radioactive materials appears to be smaller for a given heat treatment. It was also determined that both the nonradioactive and radioactive materials lose catalytic activity with storage time and that, therefore, this phenomenon is not related to the decay of the radioactivity, but is a property of the catalyst surface. From this it was concluded that the emission of beta particles from the catalyst during the time the dehydration reaction was taking place was of no consequence. This conclusion was supported by the fact that irradiation of the catalysts with x rays or electrons while the reaction was proceeding had no effect. Preirradiation of the catalyst with Co^{60} gamma rays was also shown to have no significant effect. Other conclusions are that the reaction is first order with respect to the partial pressure of cyclohexanol and that it may be limited in extent by the attainment of equilibrium. The products, regardless of the catalyst used or its radioactivity, were limited to cyclohexene and water. It is also concluded that water, while it may play a part in the aging processes, does not strongly poison the catalyst at temperatures above 350°. Average values for the apparent activation energies found were about 24 and 28 kcal/mole for fresh and aged magnesium sulfate and 23 and 29 kcal/mole for fresh and aged magnesium sulfate containing 0.98 to 2.43% sodium. Considerable variation was found in the latter case. (P.C.H.)

PHYSICS

General and Miscellaneous

12743 (AD-277626) GENERATION AND USE OF PULSED MAGNETIC FIELDS. Technical Note No. 11. Colin S. Gaskell (Oxford Univ. Engineering Lab.). [1962]. Contract AF61(514)-1183. 21p.

Methods of generating high magnetic fields are surveyed, and the design and construction of a pulsed field set are described. Capacitors are used to store the energy, and are discharged through a triggered spark gap into a special wire-wound solenoid. By this method, fields up to 280 kilogauss have been produced. A method of plotting magnetisation curves in high fields is described, and results are given for gadolinium. Sources of error and possible improvements in the experimental technique are discussed. (auth)

12744 (AD-277917) CESIUM PLASMA STUDIES FOR THERMIONIC ENERGY CONVERSION. Final Report. R. C. Knechtli and J. Y. Wada (Huges Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). June 1962. Contract Nonr 3501(00). 30p.

A new method for measuring the volume recombination coefficient a of thermal cesium plasmas in steady state has been devised and perfected. In this method, a thermal cesium plasma column is magnetically confined between two plasma generators. The plasma is generated by contact ionization and thermionic emission. The rate of plasma generation is controlled by the cesium vapor pressure in the device, the latter being directly measured in absolute value. The rate of plasma loss (in the range of measurement of a) is predominantly controlled by volume recombination, i.e., by a and by the plasma density. The latter is measured by Langmuir probes. The recombination coefficient is then found as a function of the measured ion and neutral densities by equating the rates of ion generation and ion loss. The dynamics of plasma generation and loss in the apparatus described above has been analyzed in order to provide the relations needed for the determination of the volume recombination coefficient a as a function of the measured ion and neutral densities. Interpretation of measurements performed at relatively low densities ($n_+ < 4 \times 10^{12}$ ions/cm^3) indicate as an auxiliary result of these investigations that the probability of surface recombination of cesium ions on tantalum or tungsten appears to be substantially lower than that predicted by the Saha-Langmuir equation. Within the accuracy of our method of measurement, the values of a obtained in our experiments are in agreement with the values predicted by the theory of recombination by electron-electron-ion collisions. These seem to be the first extensive measurements providing quantitative verification of this theory. These measurements then lead to the conclusion that recombination by electron-electron-ion collisions predominates within the ranges of plasma densities (10^{12} to 10^{14} cm^{-3}) and degrees of ionization (5% to 90%) investigated. The numerical values obtained for a also show that volume recombination is of negligible importance in the operation of cesium plasma thermionic energy converters. A modification of the apparatus used for the recombination measurements has led to the observation of low frequency oscillations in a cesium plasma column between a plasma emitter and a collector. A simple physical model explaining these oscillations has been evolved, and a mathematical analysis based on this model has been performed. General agreement between theory and experiment has been found, leading to a satisfactory explanation of these oscillations, that seem to be of the same nature as those observed in some cesium plasma thermionic energy converters. The results of our investigations thus lead to an appropriate explanation for these converter oscillations. (auth)

12745 (AD-277940) THE DEVELOPMENT OF AN AUXILIARY ELECTRODE THERMIONIC CONVERTER. Second Quarterly Technical Report, March 15, 1962 to June 15, 1962. F. G. Block and J. J. O'Grady (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). June 29, 1962. Contract AF33(657)-8005. 35p.

The feasibility and development program for the three-electrode thermionic converter was continued. Evaluations of several new geometries and processes were made with particular emphasis on the improvement of cesium purity. This last investigation produced impressive results in raising the power density and efficiency of the converters and achieving a more uniform product with which to evaluate changes in design. The overall design of the six-volt generator was determined. This design is being translated into component prints and assemblies and orders have been placed for the fabrication of the initial parts. Material investigations were performed at the three temperatures of interest. The program requires a 1000-hour test. This limitation resulted in a few evaluations of material compatibility with cesium. (auth)

12746 (AD-278116) SUPERCONDUCTING PROPERTIES OF ELECTROPLATED THIN CYLINDRICAL TIN FILMS (thesis). Edward F. Jardin, Jr. and Charles S. McCloskey, Jr. (Naval Postgraduate School, Monterey, Calif.). 1962. 36p.

Tin films were electroplated on No. 35 Nichrome wire using a multiple specimen production technique. Identical specimens were tested to ascertain critical currents and temperatures for superconducting films of thicknesses from 1225 to 13,000 angstroms. Critical temperatures were found to decrease monotonically with film thickness. Critical currents were observed to decrease markedly in the two thinnest films. Future work in thin films would be greatly facilitated by utilizing identical specimens. (auth)

12747 (AFCRL-62-373) STUDIES OF ELECTRON TUBE MATERIALS AND THERMIONIC EMISSION PROCESSES. Eighth Scientific Report, January 1, 1962–March 31, 1962. (General Telephone and Electronics Labs. Inc., Bayside, N. Y.). Contract AF19(604)-7286. 41p. (AD-277556)

The thermionic emission properties of ultra-pure nickel-base oxide cathodes in the clean test diode are being investigated. A comparison of the emission results for active N4 and ultra-pure nickel-base cathodes shows that the active nickel-base cathodes are well activated after the four high-temperature processing treatments. The sublimation characteristics of a barium oxide platinum-base cathode were studied. The evaporation rates of molecular BaO as measured by the retarding field technique were in excellent agreement with previously reported values based upon mass spectrometric, chemical and radioactive tracer methods. Full operation of the Knudsen cell-mass spectrometer system provided an initial calibration of the instrument. The presence of silver and molecular beam op-

eration was confirmed by a measurement of the isotopic abundance of the ions in question, by the mass scale constants for the instrument and by operation of the molecular beam shutter. The electron emissive properties of a triple oxide cathode were displayed on the screen of a 24-inch diameter sealed-off emission microscope tube. The size and location of emission sites were observed. (auth)

12748 (AFOSR-2956) AN EXPERIMENTAL STUDY OF THE SURFACE WAVES GENERATED BY A TIME VARYING MAGNETIC FIELD (thesis). Glenn C. Light (Cornell Univ., Ithaca, N. Y. Graduate School of Aeronautical Engineering). Feb. 1962. Contract AF49(638)-544. 27p. (AD-277712)

Surface waves have been generated on a circular pool of mercury by means of induced currents. A discharge through a pair of coaxial coils generates and induces currents in the mercury; these currents in turn interact with the currents in the coils to produce a force. The geometry constitutes the free-surface analogy of the circular pinch. The height of the free surface is analogous to the density in an infinite column of compressible gas. In the experiments reported here only weak disturbances are considered. A theoretical relation for the height of the disturbances is derived from the analogous gasdynamic problem. The theory is in good agreement with the measured values of the disturbance height. The success of these initial experiments indicates the possibility of obtaining useful information on the containment problem by exploitation of the free-surface analogy. (auth)

12749 (ANL-6673) A TABLE OF THERMODYNAMIC PROPERTIES OF HYDROGEN FOR TEMPERATURES FROM 100 TO 3000°K AND PRESSURES FROM 1 TO 50 ATMOSPHERES. Charles E. Cohn and Gerald H. Golden (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 269p.

Thermodynamic properties of gaseous hydrogen at temperatures of 100 to 3000°K and under varying pressures in different parastate percentages are given. The density, enthalpy, entropy, and fraction of gas molecules dissociated are included for each entry. (D.C.W.)

12750 (ARF-1183-4) FEASIBILITY OF NEUTRON DIFFRACTION STUDIES IN HIGH PRESSURE. Final Report. G. H. Wolfe and L. Reiffel (Illinois Inst. of Tech., Chicago. Armour Research Foundation). May 10, 1962. Contract AF49(638)-1010. 22p. (AFOSR-2641; AD-277846)

The feasibility of taking neutron diffraction data on specimens under high hydrostatic pressure is examined since such an approach would open up new ways of attacking problems in physics. The Laue technique is used with rubidium iodide and rubidium chloride crystals under pressures to about 80,000 psi. Considerations involved in constructing the high pressure chamber and in passing the neutron beam in and out of the chamber are discussed and, diagrams of the apparatus and patterns obtained at various pressures are shown. The experiments confirm the feasibility of using the technique at pressures up to, at least, 80,000 psi. (D.C.W.)

12751 (ARF-1214-1) A NUCLEAR-PHOTON ENERGY CONVERSION STUDY. Quarterly Technical Report No. 1, April 1, 1962–July 1, 1962. H. V. Watts and C. W. Terrell (Illinois Inst. of Tech., Chicago. Armour Research Foundation). July 13, 1962. Contract AF33(657)-8527. 34p. (AD-278364)

Capabilities of materials that could possibly be used in the components of a nuclear radiation powered electrical energy source that consists of a radioisotope, a luminescent material, and a photovoltaic device are discussed. Considerations affecting the efficiencies of the components are examined. A silicon junction solar cell is selected as the photon-to-electrical energy converter, and a cadmium sulfide phosphor activated with silver or copper is chosen for nuclear radiation-to-photon conversion. Beta-emitting radioisotopes, particularly strontium-90, are presently used as emitters. (D.C.W.)

12752 (ASD-TDR-62-94) SOLAR THERMIONIC ELECTRICAL POWER SYSTEM. D. L. Cuthbert, D. L. Purdy, E. W. Williams, J. A. Ruff, D. L. Kerr, W. G. Flanigan, R. Luck, Jr., D. Jones, and E. Baum (General Electric Co. Missile and Space Vehicle Dept., Philadelphia). Mar. 1962. Contract AF33(616)-7008. 148p. (AD-277555)

Progress is reported on the design and development of a solar thermionic electrical power system (STEPS). The design objective was to size the system to generate 500 watts of electrical power in space when operating in a simulated orbit over a 35-minute-dark, 55-minute-light cycle. Vacuum thermionic converters were used. The system was to be ground-operated with the hardware as close to flight type as possible. Details of the design, development, fabrication, and performance of the system are included. (auth)

12753 (BNL-6717) TRAJECTORIES FOR A RECTANGULAR MAGNET WITH UNIFORM FIELD. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Feb. 7, 1963. Contract [AT(30-2)-Gen-16]. 7p.

To aid in orientation of a hodoscope system using a rectangular magnet with a uniform field, projections of the trajectory of particles in the horizontal and vertical planes are calculated approximately. Fringing field effects are represented by adding a correction to the length of the magnet and assuming the field to be uniform over the total effective length. The assumption that the source lies in the median plane of the magnet is also used in treating the vertical motion. (D.C.W.)

12754 (CEA-2189) TABLES OF RANGE AND RATE OF ENERGY LOSS OF CHARGED PARTICLES OF ENERGY 0.5 TO 150 Mev. C. Williamson and J. P. Boujot (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 460p.

The range, rate of energy loss, and differential of rate of energy loss have been tabulated for 29 target materials for all hydrogen and helium ions. The incident energy range covered is from 0.5 Mev to 150 Mev, in energy steps not exceeding one Mev. (auth)

12755 (JINR-P-1121) DIELEKTRICHESKII TOR V ELEKTRICHESKOM POLE. (Dielectric Torus in Electric Field). A. B. Schwartsburg (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1962. 6p.

An electrostatic problem for thin dielectric and conducting rings in an external field is considered for cases of axial-symmetric and homogeneous fields. Dipole and quadrupole moments acquired by the rings in these fields are found. (auth)

12756 (JINR-P-1126) OB INFRAKRASNYKH OSOBENNOSTYAKH. (On Infrared Singularities). O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 6p.

It is shown that in considering the electromagnetic field in the phase diagonal representation the "infrared catastrophe" does not appear. (auth)

12757 (N62-10970) VORTEX MHD GENERATOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly

Progress Report No. 3, July 1961. W. C. Davis, R. J. Coerdt, R. T. Craig, and W. J. Skinner (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Contract NAS5-703. 14p. (ER-4540)

Environmental tests for vortex generators have been made using CsOH-seeded, arc-heated argon with MHD linear channels. Operation times of up to twelve minutes are obtained using tungsten electrodes and careful seeding. Boron nitride is found preferable for the sidewalls. Characteristics of the MHD linear channel in an 8200-gauss field are displayed, and acceptable plasma conductivities are reported. Velocity profile shapes (some are displayed) for the hot gas vortex generator reveal that turbulence is quite severe at low U/V ratios. Hot gas operation of the vortex generator for periods of up to seventeen minutes yields low output voltages due to shorting and an internal impedance of 11.8 ohms that implies a plasma conductivity of 0.01 mho/cm. Theoretical predictions of the velocity profile of a two-dimensional vortex that agree well with experiment can now be made. (D.C.W.)

12758 (N62-11118) RESEARCH AND DEVELOPMENT STUDY OF A MAGNETIC INDUCTION PLASMA ENGINE. Quarterly Progress Report. (Clauser Technology Corp., Torrance, Calif.). July 28, 1961. Contract NAS-5-1091. 15p.

Arrangements to produce traveling magnetic fields for electrodeless acceleration of plasmas rare in magnetic induction engines are discussed, and design and construction of a Helmholz coil arrangement selected for initial research are reported. Structural soundness of the arrangement is found, and design and operation of associated components such as coil current triggers and switches, vaccum system and gas feed, diagnostic instrumentation, and the preionizing system are briefly treated. A program of initial experiments is presented, and studies of the problem of heat transfer from the plasma to the wall are reported. (D.C.W.)

12759 (N62-11129) VORTEX MHD GENERATOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 1. W. C. Davis, R. T. Craig, and W. J. Skinner (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Jan. 1961. Contract NAS5-703. 13p. (ER-4322)

Development of facilities to permit tests on plasma seeding is reported, and the arrangements are described. Results of K_2CO_3 and Cs_2CO_3 seedings of hydrogen–oxygen combusion show that reasonable electrical conductivity is obtained. Initial tests on K_2CO_3 seeding of argon gas show poor conversion of arc power to gas enthalpy, resulting in inadequate plasma conductivity. This difficulty has been surmounted as has the destruction of the arc head by interaction with the generator magnetic field. The two Vortex MHD generators are described, and their expectedly unsuccessful operations on arc-heated argon plasma are discussed. Laminar flow is noted to be inadequate for study of vortex motion, and completion of experimental and theoretical study of turbulence in plane two-dimensional flows is reported. (D.C.W.)

12760 (NP-12500) METHODS FOR PRODUCTION OF MOLECULAR BEAMS IN THE ENERGY RANGE OF 1-1000 ev. State-of-the-Art Literature Survey. R. H. Austin and J. E. Christopher (Virginia. Univ., Charlottesville, Research Labs. for Engineering Sciences). Dec. 1962. 103p. (SP-620-101-62U)

Approximately four hundred references with abstracts are compiled for research done during the period 1950-1962 on methods for producing 1-1000 ev molecular beams. (D.C.W.)

12761 (NYO-9813) ULTRAHIGH VACUUM TECHNIQUES. Quarterly Progress Report, October 1–December 31, 1962. Research Report 62-828-441-R2. (Westinghouse Electric Corp. Research Labs., Pittsburgh). Dec. 31, 1962. Contract AT(30-1)-2823. 23p.

Mass spectrometer monitoring of peaks upon flashing the target in measurement of CO photodesorption from W indicates bulk heating to be a main contribution to desorption. Study of auger electron ejection from absorption of O on W yields good agreement between calculated and measured values for electron ejection. Values for O adsorption on W are compared with other determinations, and wide variations in sticking probabilities are noted. Measurements of the conversion of O incident on W ribbons to WO_3 are found to differ considerably from other determinations. Efforts to eliminate spurious effects in the studies are discussed, and the probability of Auger electron emission is determined not to exceed 1.3×10^{-9} electrons per molecule absorbed, 10^5 less than earlier estimates. Difficulties in obtaining clearly defined flash filament adsorption data for CO on W permit only determination of an upper limit of 10^{-8} electrons per molecule adsorbed for the maximum efficiency. Studies of inelastic electron collisions with N_2, H_2, CO, H_2O, and CO_2 gases on W surfaces reveal inelastic and superelastic peaks for water vapor, only an inelastic peak for H, and unexpected absence of inelastic peaks in N_2 and CO. (D.C.W.)

12762 (NYO-10253) IRREDUCIBLE REPRESENTATIONS OF GENERALIZED OSCILLATOR OPERATORS. T. F. Jordan, N. Mukunda, and S. V. Pepper (Rochester, N. Y. Univ.). [1962]. Contract AT(30-1)-875. 29p.

All of the irreducible representations are found for a single pair of creation and annihilation operators that together with the symmetric or antisymmetric number operator satisfy the generalized commutation relation characteristic of para-Bose or para-Fermi field quantization. The procedure is simply to identify certain combinations of these three operators with the three generators of the three dimensional rotation group in the para-Fermi case and with the three generators of the three dimensional Lorentz group in the para-Bose case. The irreducible representations are then easily obtained by the usual raising and lowering operator techniques. The applicability of these techniques is demonstrated by a simple argument that shows that the commutation relations require that the generator be diagonalized to have a discrete spectrum. (auth)

12763 (ORNL-3360) NEUTRON PHYSICS DIVISION ANNUAL PROGRESS REPORT. Period Ending September 1, 1962. (Oak Ridge National Lab., Tenn.). Jan. 11, 1963. Contract W-7405-eng-26. 333p.

A total of 74 subsections are included in the report. The information in 4 subsections was previously abstracted in NSA. Separate abstracts were prepared for 38 of the subsections. Those sections for which no abstracts were prepared contain information on prompt neutron lifetime, Rover critical experiments, Pu^{239} fission, neutron decay, the 05R code, alpha scattering, S and P wavelengths, proton scattering, deuteron scattering, local optical potentials, N. S. Savannah radiation leakage, reactor shielding, cross section data analysis, gamma transport, gamma energy deposition, gaussian integration, data interpolation, neutron scattering, neutron energy deposition, space vehicles, computer analyses, shielding, positron sources, and secondary particles. (J.R.D.)

12764 (ORNL-3360(p.3-11)) PRELIMINARY REPORT ON THE MEASURED GAMMA-RAY SPECTRA FROM A STAINLESS STEEL REACTOR. G. T. Chapman, K. M. Henry, et al. (Oak Ridge National Lab., Tenn.).

The gamma-ray spectrum from a stainless steel reactor core was studied with various thicknesses of water separating the core and the air-filled, 6-ft-long spectrometer acceptance cone. Data were obtained with the acceptance cone normal to the core face and also at several angles to the normal. It was found that above an energy of 5 Mev the principal contribution to the spectrum comes from capture gamma rays born in the steel of the reactor core. Below 5 Mev the predominant peak comes from thermal-neutron captures in the water. Data are presented as pulse-height distributions. (auth)

12765 (ORNL-3360(p.12-16)) EXPERIMENTS AND CALCULATIONS ON THE REACTIVITY EFFECTS OF SMALL FUEL DISPLACEMENTS. E. G. Silver, Z. M. Bartolome, et al. (Oak Ridge National Lab., Tenn.).

The reactivity effects associated with the motion of reactor fuel are being investigated in a calculational and experimental program at the BSF. Results indicate that negative reactivities result from all perturbations that decrease the homogeneity of the core, except when the perturbation adds fuel to high-importance regions, such as those adjacent to interior water volumes. The calculation methods appear to be inadequate to cope with the kind of small-dimension, large-magnitude perturbations represented by the experiments; however, experiments are being designed which can be more accurately represented in the calculations. (auth)

12766 (ORNL-3360(p.19-21)) APPLICATIONS OF SOME INSTRUMENT-RESPONSE UNFOLDING METHODS. W. R. Burrus (Oak Ridge National Lab., Tenn.).

OPTIMO and SLOP were written for the IBM-7090 computer to unfold experimental data. Both are designed to take account of a priori information such as nonnegativity or smoothness. OPTIMO was used to unfold a neutron spectrum from the Tower Shielding Reactor II, and SLOP was applied to the unfolding of a capture-gamma-ray spectrum measured with a large NaI(Tl) crystal. (auth)

12767 (ORNL-3360(p.22-31)) THE SLOP CODE FOR THE UNFOLDING OF INSTRUMENT RESPONSE. V. D. Bogert and W. R. Burrus (Oak Ridge National Lab., Tenn.).

A variation of the ordinary method of least squares was utilized in the construction of a computer code (identified as SLOP) for the unfolding of the response of instruments such as scintillation spectrometers. The code takes advantage of a priori knowledge of the solutions sought, such as nonnegativity, knowledge that a particular spectrum may be smoothly varying, etc. The result of the application of the code is the determination of a statistical confidence interval for the unknown spectrum. A sample problem is computed for demonstration. (auth)

12768 (ORNL-3360(p.35-6)) CRITICAL EXPERIMENTS WITH MIXTURES OF AQUEOUS U^{235}-ENRICHED URANYL NITRATE SOLUTIONS AND BOROSILICATE GLASS RINGS. J. K. Fox and J. T. Thomas (Oak Ridge National Lab., Tenn.).

Several critical experiments were performed with mixtures of aqueous 92.6% U^{235}-enriched uranyl nitrate and borosilicate glass Raschig rings to provide information for nuclear safety applications. The mixtures were contained in 20-, 30-, and 48-in.-ID Al or stainless steel cylinders, and two concentrations of uranyl nitrate solutions were used, one containing 415 g of U/l and the other 279 g of U/l. The glass rings varied in size, the largest having a 1.52-in. ID, a 1.85-in. OD, and a 1.89-in. length. Their B content was 0.5 to 5.7 wt %. It was found that for solutions having a U concentration ≦415 g/liter, k_∞ will be less than 1 if the glass rings contain 5.7 wt % natural B and occupy 24.1 vol % of the mixture. For solutions having a U concentration of ≦279 g/liter, the corresponding values are 4.0 wt % natural B and 24.1 vol % glass. (auth)

12769 (ORNL-3360(p.37-8)) CRITICAL CUBIC ARRAYS OF NEUTRON-INTERACTING UNITS OF AQUEOUS URANYL NITRATE SOLUTION. J. T. Thomas and J. K. Fox (Oak Ridge National Lab., Tenn.).

Critical experiments with 5-liter units of 92.6% U^{235}-enriched uranyl nitrate solution in cubic arrays showed that the number of units required for criticality as a function of their spacing and reflector obeys the relation $N = N_0F^{-s}$, where N_0 and s are constants and F is the ratio of the average U density in the array to that in a unit. Values of the constants are given for various reflector conditions. (auth)

12770 (ORNL-3360(p.39-40)) PROMPT-NEUTRON DECAY CONSTANTS FOR UNMODERATED URANIUM METAL CRITICAL ASSEMBLIES WITH LARGE GAPS. J. T. Mihalczo (Oak Ridge National Lab., Tenn.).

Experiments in which the large metal faces of two 8 by 10 in. U (93.2 wt % U^{235}) metal slabs were separated by various distances showed that the critical thickness of each slab varies from 1.87 in. at a separation distance of 0.11 in. to 3.12 in. at a separation distance of 5 in. The prompt-neutron decay constants, measured by the Rossi-α technique, varied from 1.07×10^6 sec^{-1} to $\sim 8.9 \times 10^5$ sec^{-1} for separation distances from 0 to 1 in. and was then constant between 1 and 5 in. (auth)

12771 (ORNL-3360(p.41-3)) CRITICAL EXPERIMENTS WITH THE HEALTH PHYSICS RESEARCH REACTOR. J. T. Mihalczo (Oak Ridge National Lab., Tenn.).

A series of critical experiments were performed with the Health Physics Research Reactor both at zero power and under superprompt-critical conditions. In the zero-power experiments fission-rate distributions were measured, reactivity calibrations of various movable parts were made, and the reactivity effects of the presence of neutron-reflecting materials adjacent to the reactor were determined. Also, the static temperature coefficient of reactivity was found to be 0.31¢/°C. In the study of the superprompt-critical conditions of the reactor, reactivity increases up to 11¢ above prompt critical resulted in bursts yielding as many as 1.8×10^{17} fissions with reactor periods as short as 16 μsec and temperature increases as large as 400°C. Pressure waves generated in a portion of the core held in position by an electromagnet for bursts greater than $\sim 6 \times 10^{16}$ fissions initiated the removal of this section of the core about 225 μsec after the peak of the burst. (auth)

12772 (ORNL-3360(p.44-8)) HIGH-FLUX ISOTOPE REACTOR CRITICAL EXPERIMENT NO. 2. D. W. Magnuson (Oak Ridge National Lab., Tenn.).

Recent critical experiments in support of the nuclear design of the High-Flux Isotope Reactor were principally concerned with evaluation of the proposed reactor control devices and their effects on the power distribution. The results of the experiments led to changes in the original design of the controls. Since the data were unique to a particular design, they are not reported in detail, but the experimental method is described and typical results of control plate calibrations are given. Experimental values

of the critical neutron decay constants are shown to be in general agreement with calculations. A preliminary investigation of possible safety devices to augment the control plates in the event of an emergency shutdown is described. (auth)

12773 (ORNL-3360(p.51-63)) THE MEASUREMENT OF α AS A FUNCTION OF ENERGY. G. deSaussure, L. W. Weston, et al. (Oak Ridge National Lab., Tenn.).

The ratio, α, of the capture cross section to the fission cross section of U^{235} was measured at neutron energies of 30 and 65 kev. The results, $\alpha = 0.372 \pm 0.026$ at 30 ± 8 kev and $\alpha = 0.315 \pm 0.06$ at 64 ± 20 kev, are in agreement with previously measured values. The capture cross section of U^{238} was also determined — 0.531 barn at 30 kev and 0.340 barn at 64 kev, values which are in agreement with published data. (auth)

12774 (ORNL-3360(p.63-7)) STATUS OF PULSED-NEUTRON MEASUREMENTS IN LIGHT-WATER ICE. E. G. Silver (Oak Ridge National Lab., Tenn.).

An experiment is in progress to measure the temperature dependence of neutron diffusion parameters in light-water ice at -5 to -90°C. A pulsed-neutron source, yielding 2.4-Mev neutrons by the (D,D) reaction, is being used. Results obtained from a single ice cylinder with buckling $B^2 = 0.300$ cm^{-2} are given for temperatures of -5 and -90°C. From these results it appears that an asymptotic value of the decay constant λ is attained soon enough to permit accurate measurement over the entire temperature range of the experiment. Decay data were taken for eight cylinders from 8 to 12 in. in dia. and from 6.5 to 12 in. in height. Future experiments will extend the data to small assemblies over the same temperature range. (auth)

12775 (ORNL-3360(p.68-72)) AN APPLICATION OF PILE NOISE ANALYSIS TO MEASUREMENTS OF KINETICS PARAMETERS OF A POOL-TYPE REACTOR. M. N. Alam, A. L. Colomb, and K. M. Henry (Oak Ridge National Lab., Tenn.).

The spectral densities of a BSR-II stainless-steel-clad reactor core and two BSR-I Al-clad reactor cores were measured using pile noise analysis techniques. From these data, values of the neutron lifetime divided by the delayed-neutron effective fraction, l/β_{eff}, were computed and show good agreement with published values obtained by the pulsed-neutron technique. The methods used in assigning standard deviations to the data are briefly outlined. It is concluded that the experiments demonstrate the adequacy of reactor spectral density measurements for providing knowledge of various reactor kinetics parameters. (auth)

12776 (ORNL-3360(p.96-7)) TRANSFUSION — A NUMERICAL METHOD FOR COMPUTING LOW-ENERGY NEUTRON SPATIAL DISTRIBUTIONS. D. K. Trubey and S. K. Penny (Oak Ridge National Lab., Tenn.).

A technique for calculating neutron slowing down in shields was developed which uses transport theory for high energies and diffusion theory for low energies. Preliminary results for a point fission source in water show that the technique, which is called the Transfusion method, gives much better predictions of thermal-neutron fluxes at large distances from the source than are given by the diffusion theory. (auth)

12777 (ORNL-3360(p.100-2)) AN IBM-7090 ROUTINE FOR READING O5R TAPES. D. K. Trubey (Oak Ridge National Lab., Tenn.).

An IBM-7090 subroutine, called REDO5R, was written to expedite use of the O5R neutron Monte Carlo code. The routine, which is compatible with Fortran and the ORGDP IBM-7090 monitor system, has a buffered input so that the machine may process the neutron histories and read tape simultaneously. (auth)

12778 (ORNL-3360(p.102-4)) SHIELDING RESEARCH FOR NUCLEAR SPACE POWER PLANTS. C. E. Clifford (Oak Ridge National Lab., Tenn.).

Shielding research in direct support of the Space Nuclear Auxiliary Power (SNAP) program wherein reactors are utilized as the power source for space vehicles was initiated. It includes studies of neutron penetration through LiH and investigations of structure scattering of radiation, both aimed at assisting in the development of an efficient technique for shaping shadow shields on space vehicles. (auth)

12779 (ORNL-3360(p.105-11)) TRANSPORT OF FAST NEUTRONS THROUGH LITHIUM HYDRIDE. PART I. NEUTRON SPECTRA. V. V. Verbinski, T. A. Love, et al. (Oak Ridge National Lab., Tenn.).

Time-of-flight techniques were used to obtain the spectra of near-fission neutrons transported through a 20-cm-thick slab of LiH and emerging at angles of 0 and 30° to the normal. NIOBE calculations in which the measured source spectrum was used as input show good gross agreement with the experimental results, although in detail the 0° calculations are low by up to 45% in the region from 4 to 5 Mev and high by about the same fraction from 2.5 to 3.5 Mev. (auth)

12780 (ORNL-3360(p.111-21)) TRANSPORT OF FAST NEUTRONS THROUGH LITHIUM HYDRIDE. PART II. ANGULAR DISTRIBUTIONS. V. V. Verbinski, T. Fuse, et al. (Oak Ridge National Lab., Tenn.).

Integral-type measurements of the angular variation of neutron fluxes leaking from LiH slab were made with threshold detectors and the results compared with the predictions of a neutron transport calculation. The computed spectrum for each angle was weighted with the activation cross section of the detector to obtain the predicted angular variations of detector activation. The detectors were Pu^{240}, Np^{237}, U^{238}, S, and Al, having effective thresholds of approximately 0.001, 0.75, 1.5, 3.5, and 7 Mev, respectively. Two components of leakage neutrons were apparent; a collimated and a diffuse component. The former is the uncollided plus small-angle-scattered flux The diffuse component appears to have an angular distribution that is invariant with depth of penetration; however, above a few Mev its slope increases with energy. (auth)

12781 (ORNL-3360(p.122-33)) SHIELDING AGAINST PROMPT WEAPONS RADIATION. L. B. Holland, V. R. Cain, et al. (Oak Ridge National Lab., Tenn.).

An experimental and calculational program relating to the penetration of prompt weapons radiation into shielded and open underground configurations was carried out. The source of radiation was the Tower Shielding Reactor II modified to give a radiation leakage similar to that from a weapon, and the undergound installations to be studied were simulated by vertical concrete-lined cylindrical holes, 4 ft in dia. and 20 ft in depth, dug in the ground at distances of 53, 161, and 435 ft from the reactor pool. A horizontal tunnel 10 ft below ground level was connected with the hole nearest the reactor. Measurements were made at positions within the holes while they were covered with various thicknesses of Fe or concrete shields. Typical results are reported. (auth)

12782 (ORNL-3360(p.137-81)) MONTE CARLO CALCULATIONS ON INTRANUCLEAR CASCADES FOR INCIDENT-PARTICLE ENERGIES FROM ABOUT 50

TO 350 Mev. H. W. Bertini (Oak Ridge National Lab., Tenn.).

Calculations were made for nucleons and pions incident on complex nuclei at energies where pion production is not likely (≈350 Mev). The interaction with the nucleus as a whole is represented by individual particle-particle collisions within the nucleus where the history of each particle involved in the collision is traced. Extensive comparisons with experiment are made to examine the limits of validity of the model. The effect of a diffuse nuclear edge is examined for certain reactions. It is demonstrated that the model can be used to predict a broad range of experimental results for incident nucleons, whereas the predictions for incident pions are not as reliable as those for nucleons when detailed information is required. It is shown that the bulk of the effects which result when a diffuse nuclear edge is used comes from the increased nuclear dimensions rather than from the edge itself. (auth)

12783 (ORNL-3360(p.182-98)) COMPILATION OF REACTIONS CALCULATED FOR PARTICLES WITH ENERGIES FROM ABOUT 50 TO 350 Mev. H. W. Bertini and L. Dresner (Oak Ridge National Lab., Tenn.).

A compilation is being prepared that will give the calculated results of incident nucleons and pions on complex nuclei. This will include the results of the cascade phase and the evaporation phase of the reaction. The compilation itself will contain graphs and tables of representative cases for incident protons and neutrons with energies from 25 to 400 Mev on nuclei from C to U, and for incident π^+ and π^- with energies from 25 to 300 Mev on nuclei in the same range. Some preliminary results are given here, and the data that will be available on request is listed. It is estimated that the completion time of the compilation is three or four months. (auth)

12784 (ORNL-3360(p.199-203)) MONTE CARLO CALCULATIONS ON INTRANUCLEAR CASCADES FOR INCIDENT-PARTICLE ENERGIES FROM ABOUT 50 Mev TO 2 Gev. H. W. Bertini (Oak Ridge National Lab., Tenn.).

The intranuclear cascade calculation which was completed for incident particles with energies below the region where pion production is likely is being extended to include pion production. The basic premises of the calculation remain the same. The isobar model is being used to determine the collision products when pion production occurs. It is assumed that the $T = {}^3/_2$ isobar alone is involved in any production collision, so that single and double pion production will be permitted in nucleon-nucleon collisions while single production only will be allowed in pion-nucleon collisions. When some of the required data for use with the isobar model are not available, simplifying assumptions are made in order that the data can be calculated. The calculation is now in the coding and debugging stage, and it is estimated that the code will be ready for production in about 6 months. (auth)

12785 (ORNL-3360(p.204-13)) A CODE GROUP APPLYING THE MONTE CARLO METHOD TO THE COMPUTATION OF THE TRANSPORT OF NUCLEONS OF ENERGY LESS THAN 400 Mev. W. E. Kinney, R. R. Coveyou, and C. D. Zerby (Oak Ridge National Lab., Tenn.).

The interaction of a high-energy proton with the material of a radiation shield initiates a complex avalanche of lower-energy secondary particles, which then proceed through the shield. A knowledge of the behavior of this cascade is necessary in the design of shielding for space vehicles or high-energy accelerators. A code grouping of existing codes with newly devised codes now enables the calculation of the events, including cascades and nuclear particle evaporation from excited nuclei, which result from the interaction of <400-Mev nucleons with shield materials. Flow charts and an example of typical results are shown. (auth)

12786 (ORNL-3360(p.215-20)) AN IMPROVED CODE FOR THE NUMERICAL ANALYSIS OF A NUCLEON-MESON CASCADE. R. G. Alsmiller, Jr., F. S. Alsmiller, and J. E. Murphy (Oak Ridge National Lab., Tenn.).

An IBM-7090 code is being written to solve the nucleon-meson cascade equations in the straight-ahead approximation. The equations to be solved are discussed, and the way these equations differ from those which were used previously is described. (auth)

12787 (ORNL-3360(p.221-4)) TWO CATEGORIES OF SOLUBLE NUCLEON-MESON CASCADE EQUATIONS. F. S. Alsmiller and R. G. Alsmiller, Jr. (Oak Ridge National Lab., Tenn.).

Analytic solutions to the one-dimensional nucleon-meson cascade equations are given for two classes of separable secondary energy distributions under the conditions that the slowing down of charged particles and the energy dependence of the nonelastic cross sections may be neglected. (auth)

12788 (ORNL-3360(p.225-9)) COMPARISON OF PRIMARY PROTON DOSE WITH THE DOSE FROM GAMMA RAYS PRODUCED BY INELASTIC SCATTERING OF SOLAR FLARE PROTONS. F. S. Alsmiller, R. G. Alsmiller, Jr., and D. K. Trubey (Oak Ridge National Lab., Tenn.).

The primary proton dose resulting from solar flare (May 10, 1959) protons incident on an Al shield is compared with the dose from gamma rays produced by inelastic collisions of the primary protons. Both spherical shell and slab shields are considered. (auth)

12789 (ORNL-3360(p.231-5)) TISSUE DOSE RATE FROM BREMSSTRAHLUNG RADIATION BEHIND AN IDEALIZED APOLLO VEHICLE WALL EXPOSED TO ELECTRONS IN THE EARTH'S OUTER RADIATION BELT. C. D. Zerby, H. S. Moran, et al. (Oak Ridge National Lab., Tenn.).

Calculations were performed to obtain the tissue dose rate from bremsstrahlung radiation behind an idealized Apollo vehicle wall exposed to electrons in the most intense part of the earth's outer radiation belt. The wall thickness was assumed to be 2.75 g/cm^2, and the resulting tissue dose rate was 8.58×10^{-3} rad/hr. (auth)

12790 (ORNL-3360(p.236-8)) TISSUE DOSE RATE FROM BREMSSTRAHLUNG RADIATION BEHIND AN IDEALIZED APOLLO VEHICLE WALL EXPOSED TO ELECTRONS IN THE ARTIFICIAL RADIATION BELT. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

Calculations were performed to obtain the first-order estimate of the tissue dose rate from bremsstrahlung radiation behind an idealized Apollo vehicle wall exposed to electrons in the most intense part of the earth's artificial radiation belt. The resulting calculated tissue dose rate is 1.91 rads/hr. (auth)

12791 (ORNL-3360(p.241-8)) PRELIMINARY RESULTS FROM EMULSIONS EMBEDDED IN A CONCRETE SHIELD EXPOSED TO A NARROW 9-Gev/c INCIDENT PROTON BEAM. R. L. Childers (Oak Ridge National Lab., Tenn.).

Preliminary measurements were made on a set of nuclear emulsions exposed at various depths in barytes con-

crete on which an incident beam of 9-Bev/c protons impinged. The plates were exposed along the center line of the nuclear cascade only. Measurements of both the star density and track density indicate an attenuation length of about 165 g/cm^2 along the center line. The presence of μ-mesons is made evident by the nonexponential drop-off of the track density at great depths. (auth)

12792 (ORNL-3360(p.248-56)) A MONTE CARLO CALCULATION OF THE THREE-DIMENSIONAL DEVELOPMENT OF HIGH-ENERGY ELECTRON-PHOTON CASCADE SHOWERS. C. D. Zerby (Oak Ridge National Lab., Tenn.).

A general-purpose Monte Carlo program for study of the three-dimensional development of high-energy electron-photon cascade showers in a homogeneous medium is described. (auth)

12793 (ORNL-3360(p.256-60)) COLLIMATOR STUDIES FOR HIGH-ENERGY ELECTRON BEAMS. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.).

Calculations to determine the effectiveness of collimators in high-energy electron beams are described. Numerical results for 5-Bev electron beams incident on two Al collimators with inside radii of 0.3175 and 0.7239 cm are reported. (auth)

12794 (ORNL-3360(p.272-80)) PROTON INTENSITY MEASUREMENTS. R. T. Santoro, R. W. Peelle, et al. (Oak Ridge National Lab., Tenn.).

Equipment and methods developed to accurately position target and detector equipment for experiments employing a synchrocyclotron are described, as are experiments leading to a detailed knowledge of beam profile, beam monitoring methods, and time distribution of protons within the beam. (auth)

12795 (ORNL-3360(p.281-5)) PROTON-RECOIL TELESCOPES FOR SPECTRAL MEASUREMENTS OF NEUTRONS AND PROTONS WITH ENERGIES >10 Mev. W. A. Gibson, W. R. Burrus, and C. F. Johnson (Oak Ridge National Lab., Tenn.).

Two proton-recoil telescopes were constructed, the first to measure spectra of neutrons having energies in the range from ~8 to 50 Mev and the second to measure those in the range from 50 to 150 Mev. Tests with neutrons produced by bombarding a Cu target with 156-Mev protons indicate that modification of the low-energy telescope is needed to reduce backgrounds. Similar tests show essentially satisfactory performance of the high-energy telescope. The telescopes, with minor modifications, can also be used for proton spectral measurements. (auth)

12796 (ORNL-3360(p.286-95)) FLIGHT-TIME SPECTROSCOPY FOR NEUTRON AND PROTON YIELDS FROM NUCLEI BOMBARDED BY PROTONS. R. W. Peelle, T. A. Love, and G. A. Luce (Oak Ridge National Lab., Tenn.).

Flight-time spectroscopy is to be employed for measurements of thick-target yields and differential cross sections for interactions of 50- to 700-Mev protons with nuclei. The spectrometer design includes provision for counting individual protons incident upon the target, detection of target-produced neutrons, and identification of events caused by protons scattered from the primary beam. Modifications to the original equipment, made as a result of preliminary tests using a 25.2-g/cm^2-thick Cu target and 156-Mev protons, are discussed. Some preliminary results are also shown. (auth)

12797 (ORNL-3360(p.296-305)) BONNER SPHERES AND THRESHOLD DETECTORS FOR NEUTRON SPECTROSCOPY. W. R. Burrus (Oak Ridge National Lab., Tenn.).

The application of so-called "Bonner spheres" to the measurement of neutron spectra over the energy range from thermal to ~10 Mev was investigated in preliminary experiments at the Harvard synchrocyclotron. The feasibility of augmenting the Bonner sphere data above 10 Mev with threshold detector data was also examined. Bonner spheres appear to be useful and will be studied further; the use of threshold detectors was abandoned. (auth)

12798 (ORNL-3360(p.306-9)) SPECTROMETRY FOR GAMMA RAYS FROM PROTON-BOMBARDED NUCLEI. W. Zobel (Oak Ridge National Lab., Tenn.).

A three-crystal gamma-ray spectrometer was constructed for the measurement of secondary gamma rays resulting from the bombardment of various nuclei by ~156-Mev protons. It will be used as a total-absorption spectrometer for low-energy gamma rays (<2 Mev) and as a pair spectrometer for higher energies. Preliminary experiments in which accelerator targets of Al and Cu were used indicate that the design must be modified to reduce backgrounds caused by target-neutron interactions in the spectrometer shield. (auth)

12799 (ORNL-3360(p.310-12)) DOSIMETRY. F. C. Maienschein and T. V. Blosser (Oak Ridge National Lab., Tenn.).

During preliminary experiments at the Harvard synchrocyclotron an attempt was made to obtain very approximate dose rates with fast-neutron and gamma-ray dosimeters designed for measurements of reactor radiations. Most of their use came in investigating extraneous room background. Because of their high-energy proton response, the dosimeters will not be used in future work. One dose measurement will be attempted, however—the measurement of the physical dose due to all secondaries, regardless of type, in the interior of a 45-cm-dia spherical water-filled phantom. (auth)

12800 (ORNL-3360(p.315-17)) ION EXCLUSION IN POROUS-BED SALT FILTERS. Lawrence Dresner (Oak Ridge National Lab., Tenn.).

Ionic exclusion in packed beds of surface-charged particles was studied with two special models of the fixed-charge distribution for which the Poisson-Boltzmann equation is exactly soluble. In the case of good co-ion exclusion, simple formulas were obtained for the equilibrium co- and counter-ion concentrations. (auth)

12801 (ORNL-3360(p.317-19)) ELECTROKINETIC PHENOMENA IN CHARGED MICROCAPILLARIES. Lawrence Dresner (Oak Ridge National Lab., Tenn.).

Electrokinetic pehnomena in small surface-charged capillaries were studied. Fluid flow was described by the Navier-Stokes equations, the ionic diffusion by the Planck-Henderson equation, and the electric field by Poisson's equation. In the case of good co-ion exclusion from the capillary, the coefficients in the linear laws relating water flow and counter-ion current to pressure, concentration, and electrical gradients were explicitly calculated. Some numerical calculations of electrokinetic quantities were carried out. (auth)

12802 (PR-P-55) PHYSICS DIVISION PROGRESS REPORT, JULY 1 TO SEPTEMBER 30, 1962. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 82p. (AECL-1659)

Study of reactions produced by 14-Mev neutrons on nickel, iron, and titanium isotopes is based on optical model considerations. Application of the liquid drop model

to fission studies is reported as is research on using californium-252 in calibrating solid state detectors. Doppler shifts of gamma rays from the 1.35 and 1.56-Mev levels in fluorine-19 are found to be 0.2 ± 0.3 and 1.95 ± 0.2%, respectively. Assignments of $\frac{1}{2}$ and $\frac{5}{2}-$ for 3.06 and 3.85 Mev states in oxygen-17 are noted. Reactions between carbon-12 and nitrogen-14 nuclei and other carbon-12 nuclei are being studied to determine reaction mechanisms and resonant spins. Equilibrium charge distributions of chlorine and iodine ions passing through an oxygen gas stripper are also investigated. No simple correlation is found between cosmic ray diurnal variations and magnetic K_p and solar flare area indexes. Angular correlation between various transitions in iodine-125 have been measured, and attempts to determine spins of iodine-127 excited states are reported. E2/M1 mixing ratio from the 279-kev transition in thallium-203 is redetermined. Branching ratios in zinc-65 and niobium-95 decay are also examined. Attempts to observe phonons in liquid tin reveal no evidence for their existence. Polarization vectors of normal modes for germanium have been determined, and frequency distribution function in sodium is reported. Angular correlation (γ-γ) work on argon-40, krypton-83, xenon-131, and mercury-199 determines spin of various energy levels. Work by the electronics branch includes reactor instrumentation, pulse analyzing systems, automatic control and recording equipment, reactor irradiation studies, components studies, and work with other devices. Neutron flux distributions in antimony-beryllium systems are being investigated as are the energies of negative parity levels in fluorine-19 and oxygen-17. Computer programs for optical model calculations have been prepared, and an exact solution of coupled equations of inelastic scattering theory is discussed. Methods for treating irregular Coulomb wave functions, large second-order effects in the Coulomb excitation of fluorine-19, reorientation effects in heavy ion Coulomb excitation, and axially symmetric problems in elasticity are also being studied. Thirty-three reports, lectures, and publications prepared during the period are listed. (D.C.W.)

12803 (RADC-TDR-62-172) REFLECTED ION BEAM RECORDING ON DIELECTRIC FILMS. J. Litton (Martin-Marietta Corp. Aerospace Div., Baltimore). Mar. 1962. Contract AF30(602)-2554. 31p. (AD-278113)

The theoretical studies and experimental work for a unique reflected ion beam recording technique are discussed. The results of literature surveys of particle deposition methods and positive ion generation techniques are presented with a theoretical solution to the interelectrode field distribution in the specimen stage. Also presented is a description of the electron and ion guns used for recording, the results of a readout methods study, and the results of the ion deposition experiments. (auth)

12804 (RRL-101) OPTICAL STUDIES OF ANISOTROPIC COLOR CENTERS IN GERMANIUM-DOPED QUARTZ. A. Halperin and J. E. Ralph (Mellon Inst. Radiation Research Labs., Pittsburgh). Jan. 24, 1963. Contract AT(30-1)-2310. 37p.

The optical absorption induced by x rays in Ge-doped quartz was investigated using polarized light. The wavelength range was 220 to 800 mμ, and the behavior of the various bands was examined at 77 to 600°K. A study of the optical bleaching of the bands and the effects of exchange of interstitial monovalent ions by electrical diffusion is also reported. The results are discussed and correlated with results of electron paramagnetic resonance measurements carried out on the same specimens. (auth)

12805 (AEC-tr-5642) TRANSITION RADIATION. N. P. Klepikov. Translated for Oak Ridge National Lab., Tenn. from Vestnik Moskov. Univ. Ser. Fiz.-Mat. i Estestven. Nauk, 6: 61-7(1951). 9p.

Equations for the electromagnetic field and transition radiation associated with the movement of an electron from one medium to another are derived. The energy irradiated by the electron upon approaching the separation boundary of the media under the effect of its accelerated ion by "reflection forces" is estimated and found to be insignificant in comparison with the transition radiation. (D.C.W.)

12806 ON THE TIME-DEPENDENT ELECTROLUMINESCENT SPECTRA OF SINGLE ZnS CRYSTALS. J. Schanda (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 14: 95-103(1962). (In English)

Measurements were carried out on ZnS grains embedded in a dielectric matrix. The electroluminescent spectral energy distribution of single ZnS particles was measured with the phase-angle of the exciting voltage as the parameter. Different grains act differently; there are some that luminesce in both half cycles and others that emit light only in one half cycle. The maximal light intensity is emitted by the different particles at different phase angles. (auth)

12807 INVESTIGATION OF THE ELECTROLUMINESCENCE OF ZnS SINGLE CRYSTALS. W. E. Oranowski (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung., 14: 115-19(1962). (In German)

On the basis of microscopic studies on ZnS single crystals, it was established that the luminescing layers consist of regions that have phase positions differing from the exciting voltage. The occurrence of the luminescence is probably connected not only with the field intensity of the electric field, but also with the very considerable free path of the electrons. The observations carried out on single crystals activated with Cu and Mn indicate the variation between the excitation mechanisms of the Cu and Mn centers. (tr-auth)

12808 SOME REMARKS ON THE PHOTOELECTROLUMINESCENCE OF ZnS SINGLE CRYSTALS. P. Sviszt and J. Schanda (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 14: 121-5(1962). (In English)

The d-c and a-c photoelectroluminescence was examined in contacted ZnS single crystals. The crystals could be divided into several groups. In some crystals under the joint action of uv radiation and direct voltage a special luminescence phenomenon could be observed, that moved from the positive electrode towards the negative. The characteristics of this luminescence are discussed. (auth)

12809 DISPLACEMENT OF THE ABSORPTION EDGE OF ZnS SINGLE CRYSTALS IN THE ELECTRIC FIELD. S. Damašková and K. Pátek (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Acta Phys. Acad. Sci. Hung., 14: 127-30(1962). (In German)

The effect of a displacement of the absorption edge in an electric field was investigated in ZnS single crystals of hexagonal structure. An electric field of the order of magnitude of 10^4 v/cm has two different directions against the c axis of the crystal. For an electric field perpendicular to the c axis, a displacement of 4 to 20 Å could be established in the direction of larger wave lengths. For a field parallel to the c axis, the effect is an order of magnitude smaller or does not exist. This displacement of the absorption edge can not be explained by crystal warming or

lattice deformation. The interpretation of the results was discussed using the Franz and Keldysch theory or another electro-optical effect. (tr-auth)

12810 INDIUM AS COACTIVATOR IN ZnS(Cu) PHOSPHORS. G. Wendel (Inst. of Technical Physics, German Academy of Sciences, Berlin). Acta Phys. Acad. Sci. Hung., 14: 145-53(1962). (In German)

Indium diffuses from about 500°C into a ZnS phosphor, but it causes no important modification of the emission spectrum. After subsequent introduction of Cu, a broad orange-red emission with a maximum at 6700 Å arises. This band can occur at small Cu concentrations of 2×10^{-6} g Cu/g ZnS. The necessary copper and indium concentration is dependent on the glowing atmosphere of the initial phosphor. The long-wave emission, in opposition to the red copper emission, was not affected by the presence of oxygen or halogen ions. On the basis of the studies it was obvious that these emissions could be ascribed to an associated copper–indium light center. (tr-auth)

12811 FLUORESCENCE, ABSORPTION AND THERMAL RADIATION OF SOLUTIONS. I. Ketskeméty, J. Dombi, and R. Horvai (Univ. of Szeged). Acta Phys. Acad. Sci. Hung., 14: 165-6(1962). (In English)

A comparatively simple expression connecting the absorption spectrum and the emission energy spectrum of fluorescent solutions obtained by Stepanov was generalized using some new fairly-evident conditions relating to the process of fluorescence. The new expression, which contains the fluorescence yield, too, renders possible the calculation of the yield as a function of the exciting wave length when the above-mentioned spectra have been determined. The generalized formula is well supported by the experimental data obtained on several dye solutions. (auth)

12812 ENERGY TRANSPORT PHENOMENA IN THE CASE OF MOLECULAR FLUORESCENCE. A. Budó and I. Ketskeméty (Univ. of Szeged). Acta Phys. Acad. Sci. Hung., 14: 167-76(1962). (In German)

The effect of secondary fluorescence on the directly measurable emission spectrum, the yield, decay time, and the degree of polarization was determined. The correlation of experimental results with theoretical considerations was briefly discussed and illustrated. The results obtained for the case of a solution containing fluorescing material were generalized to the sensitized fluorescence of mixed solutions. In the latter case the emission spectrum can be expressed as the linear combination of the fluorescent spectrum of the two dissolved materials, and the coefficients of this linear combination can be satisfactorily explained by the concentration dependence on the basis of theories by Wawilow, Forster, and Jablonski. (tr-auth)

12813 THEORY OF FLUORESCEIN-ACTIVATED $Al_2O_3 \times H_2O$ LAYER PHOSPHORS. E. Lendvay (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 14: 187-210(1962). (In English)

The luminescent spectra of $Al_2O_3 \cdot H_2O$—fluorescein layer phosphors depend on the duration of the adsorption time and the chemical treatment of the oxide film. The change of the luminescent intensity and the shift of the maximum emissivity are connected with the rate of generation of adsorbing centers on the alteration of the rate of adsorption. The measured luminescent band contains some elementary luminescent bands, which are characteristic for the luminescence of different kinds of adsorption centers. From the analysis of the measured spectra the quality of the surface and the adsorption can be concluded. (auth)

12814 INVESTIGATIONS ON THE EXTINCTION OF THE FLUORESCENCE OF 3,4-BENZOPYRENE. Z. Morlin (Research Lab. for Chemical Structures, Hungarian Academy of Sciences, Budapest) and M. Sáringer. Acta Phys. Acad. Sci. Hung., 14: 211-16(1962). (In English)

As a result of the effect of ozone, or ultraviolet irradiation, the fluorescence of 3,4-benzopyrene decreases with increasing time of treatment, i.e., with increased amount of ozone introduced into the samples. At the same time the ultraviolet absorption peaks decrease too. If the treatment continues long enough the fluorescence is extinguished altogether. According to the measurements, the fluorescence intensity versus time of the ozone treatment obeys a hyperbolic law. (auth)

12815 ON THE FUNDAMENTAL POLARIZATION OF THE FLUORESCENCE OF VISCOUS SOLUTIONS. L. Szalay, L. Gáti, and B. Sárkány (Univ. of Szeged). Acta Phys. Acad. Sci. Hung., 14: 217-24(1962). (In English)

The fundamental polarization of fluorescein in glycerine-water solutions was photoelectrically studied at a temperature of 30°C taking the spectral characteristics of polarization, the rotation depolarization, the concentration depolarization, and the influence of the secondary luminescence into account. The secondary luminescence was shown to play an important role, and allowing for it, an experimental value of the fundamental polarization very near to the theoretical one, i.e., 0.5, was found, contrary to the earlier results. Some conclusions were drawn relative to the torsional vibration and solvatation effect. (auth)

12816 RECOMBINATION LUMINESCENCE OF INDIUM ANTIMONIDE IN STRONG ELECTRICAL FIELDS. N. G. Basow, B. D. Osipow, and A. N. Hwoschtschew (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung., 14: 245-6(1962). (In German)

The infrared radiation of n conducting indium antimonide was investigated at a current density of 10^4 amp/cm^2. Current pulses of 3 μsec were used to prevent heating. Luminescence was observed at 78°K. If the sample was heated from 120 to 180°K, quenching was observed. The rise and decay times of the light pulse were less than 1 μsec. It was concluded that the emission observed was a recombination radiation. The effective temperature in the spectrum maximum was determined to be about 500°K. (J.S.R.)

12817 PHOTOLUMINESCENCE AND ASSOCIATED PHENOMENA IN NaCl CRYSTALS CONTAINING Cd AND Co. A. Bohun, J. Dolejší, M. Kaderka, J. Kantůrek, I. Kunzlová, M. Lébl, and J. Trnka (Inst. of Technical Physics, Czechoslovak Academy of Sciences, Prague). Acta Phys. Acad. Sci. Hung., 14: 247-53(1962). (In German)

The photo- and radioluminescence and other optical and electrical phenomena were followed in NaCl crystals containing Co. On the basis of the results obtained on the spectral decomposition of the luminescence, the thermoemission and thermoluminescent patterns, the absorption, and the electric conductivity, these phenomena were discussed. The luminescent mechanism in crystals containing Co was compared with that in crystals containing Cd. (tr-auth)

12818 FIELD AMPLIFICATION OF ZnCdS(Mn) PHOSPHORS UNDER ULTRAVIOLET EXCITATION. G. Wendel (Inst. of Technical Physics, German Academy of Sciences, Berlin). Acta Phys. Acad. Sci. Hung., 14: 255-66(1962). (In German)

ZnCdS(Mn) phosphors show, under x-ray excitation in alternating electric fields, an amplification of the photoluminescence. Under uv excitation an amplification was also found that is, however, smaller. This amplification is dependent on the wavelength and intensity of the uv excitation. By variation of the intensity, both an amplification and a quenching were found in dependence on the voltage and frequency of the alternating field. The results were discussed and compared with those obtained with x-ray excitation. (tr-auth)

12819 CARRIER DISTRIBUTION IN ZnS PHOSPHORS IN THE CASE OF STRONGLY INHOMOGENEOUS EXCITATION. Gy. Gergely (Research Inst. for Telecommunication, Budapest). Acta Phys. Acad. Sci. Hung., 14: 273-82 (1962). (In English)

An analysis is given of the distribution and ambipolar diffusion of carriers generated by strongly absorbed radiation (photons and electrons) in ZnS phosphors. In the analysis a three-step successive approximation is used, making use of the Klasens method, assuming neutrality condition and considering space charge effects. The distribution of carriers is calculated considering diffusion, bulk and surface recombination, and space charge effects. The effective ambipolar diffusion is a result of space charge accumulated in traps, attracting holes and retarding electrons, preventing the carriers from reaching traps located deeper in the bulk and balancing their diffusion current. The negative space charge layer has to be compensated by a positive layer. Some experimental aspects are discussed. (auth)

12820 NARROW BANDS OF THE LUMINESCENCE OF CuBr AND OF ALKALI HALIDE PHOSPHORS ACTIVATED BY CuBr. P. Sviszt (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 14: 283-94(1962). (In English)

Luminescence was examined in alkali halide phosphors activated with CuBr at room and low temperature. The phosphors contained a large amount of activator. The results demonstrated that in these cases the narrow bands in the luminescent spectra belong to the surface centers. Luminescence was also examined in CuBr at 77 and 20°K. In the 4175 to 4315 Å range a series of the narrow bands appear. The effect of gases on the luminescence of CuBr was observed. The experimental results show that in this case there are several kinds of centers and the luminescence of CuBr is connected with surface phenomena. (auth)

12821 EFFECT OF COOLING RATE ON CALCIUM HALOPHOSPHATE LUMINESCENCE. W. E. Ishler, E. F. Apple, and H. C. Froelich (General Electric Co., Cleveland). Acta Phys. Acad. Sci. Hung., 14: 295-300(1962). (In English)

The rate of cooling alters the luminescent properties (absorption, spectral emission, and emission intensity) of halophosphate phosphors in a characteristic and reversible manner. The Mn emission changes in both position and intensity, the Sb emission only in intensity, and the changes of both are dependent upon the nature of the halide. Interpretation of x-ray diffraction patterns, together with the luminescence results, leads to conclusions regarding the probable position of the halide, Mn, and Sb atoms in the lattice. (auth)

12822 SOME ASPECTS OF THE ACTIVATION OF PHOSPHORS BY TETRAVALENT MANGANESE. A. H. McKeag (General Electric Co. Ltd., Wembley, Eng.). Acta Phys. Acad. Sci. Hung., 14: 301-10(1962). (In English)

Tetravalent manganese is known to give a characteristic red emission in phosphors such as magnesium fluogermanate and magnesium arsenate. Spectral energy distribution measurements were obtained for a number of similar phosphors, including a new phosphor magnesium lithium antimony fluo-silicate. The outstandingly good temperature characteristics of magnesium fluogermanate and magnesium arsenate may be associated with their special emission characteristics which were not observed with the other phosphors examined. (auth)

12823 MEASUREMENT OF THE ABSORPTION COEFFICIENTS OF PHOSPHORS ORIGINATING FROM MICROCRYSTALLINE GRAINS. G. T. Bauer (Research Inst. for Scientific Information, Budapest). Acta Phys. Acad. Sci. Hung., 14: 311-18(1962). (In German)

A method is given for determining the absorption coefficients originating from microcrystalline grains in phosphors. By means of the diffuse reflection and transmission of slightly covered layers prepared from the sample material, the absorption coefficient could be approximately determined. The optical interaction of the grains widely separated from each other is low, so that in calculating the diffuse reflection and transmission of the layers it is sufficient to consider the optical properties of the individual grains. In the various calculations the average form of the grains was taken as spheres, as diffuse spheres with rough surfaces, or as diffuse plates. From the measurements the average form of the grains could be inferred. The results of measurements carried out on glass powders and luminescent willemites were reported. (tr-auth)

12824 ATOMIC BEAM APPARATUS FOR DETERMINING THE MEAN FREE PATHS OF POTASSIUM ATOMS IN ARGON. Robert G. Marcley (American Inst. of Physics, New York). Am. J. Phys., 31: 116-31(Feb. 1963).

A simple atomic beam apparatus of special pedagogic interest, developed specifically for an introductory laboratory, is described. It consists of an electrically heated oven for vaporizing metallic potassium, a slit system for collimating a beam of the neutral atoms, and a detection system for measuring the number of atoms that traverse a path through an atmosphere of argon at reduced pressure. The slit-detector separation can be varied from about 2 to 20 cm. The system pressure can be adjusted from about 5×10^{-4} mm Hg to 5×10^{-6} mm Hg and is determined with a conventional ionization gage. The ion gage control circuits, as well as the vacuum tube voltmeter for measuring the detector output, are low-cost "home-made" units. The relatively low-cost glass-metal apparatus is evacuated with a small 2-stage oil diffusion pump and was designed to be operated with a minimum of maintenance. Eight pieces of the apparatus have been in regular use for four years. Detailed information on construction of the basic apparatus and the ancillary electronic equipment is given. (auth)

12825 MEASUREMENT OF THE RELATIVE INTENSITY OF X RAYS OF THE L SPECTRA OF HEAVY ELEMENTS EXCITED BY ELECTRON BOMBARDMENT. Marcel Goldberg (Faculté des Sciences, Paris). Ann. Phys. (Paris), 7: 329-57(May-June 1962). (In French)

The relative intensity of the x-rays of the L spectrum produced in an x ray tube under a voltage of 50 kv were measured for Ta, W, Re, Ir, Pt, Au, Hg, Tl, Pb, Bi, Th, Pa, and U. Fifteen to twenty rays were measured in each case with the exception of Pa where only 5 rays were studied. The radiations were produced in thick targets except for Ir and Pa. The rays were separated by a curved crystal spectrograph of the Cauchois type, and a scintillation counter was

used for the detector. The variation of the relative intensity was determined as a function of Z. The existence of three L levels necessitated a study of the relative intensity of the rays of the same level and a separate study of the relative intensities of rays of different levels. The results obtained were compared with the previous experimental work and with theoretical prediction. The intensities of the rays of the same level are independent of the mode of ionization, whereas the intensities of rays of different levels are dependent on the ionization method, on the fluorescent yield of each level, and on Coster-Kronig transition coefficients. (J.S.R.)

12826 THE 1962 SCIENTIFIC CONFERENCE OF THE MOSCOW ENGINEERING PHYSICS INSTITUTE. At. Energ. (USSR), 13: 603-7(Dec. 1962). (In Russian)

The annual conferences of the Institute reached the level of the All-Union scientific meetings; more than 400 delegates, including many foreign representatives participated in the sessions held during May 1962. The following papers presented a special interest from the nuclear viewpoint: A. I. Leĭpunskiĭ discussed the future of fast-neutron reactors, pointing out that they offer a means of utilizing more efficiently the world's supply of fissionable materials and that their energy-generating potential is about the same as that of the controlled fusion reaction. A. A. Vasil'ev devoted his talk to the problems of very-high-energy accelerators. The cybernetic system will allow the paths of the particles to be traced, analyzing automatically their trajectories and controlling automatically the parameters of the accelerating systems. It will be thus possible to reduce the dimensions, the weight and the cost of the machines, while increasing the intensity of the accelerated beam. The approximate parameters of a 300 and 1000-Bev machine were presented. A. B. Migdal discussed the "Phenomenological Theory in the Multibody System," presenting an approach to the theory of the nucleus on the basis of a Fermi liquid consisting of 2 types of fermions. Yu. D. Fiveĭskiĭ showed in his paper on "Slowing Down of Average-Energy Antiprotons in Matter" that the absorption of antiprotons with an energy less than the threshold value for the generation of 2π-mesons is very small. (TTT)

12827 COSMOLOGICAL MODELS AND RELATIVITY. Stamatia Mavrides (Institut Henri Poincaré, Paris). Bol. Univ. Parana, Fis. Teorica, No. 3, 1-41(Apr. 1962). (In French)

An outline is given of static, non-static, Newtonian, steady-state, and other cosmologies. Within the frameworks of these cosmologies and general relativity, attention is given to the Hubble effect, the concept of distance, the age of the universe, and "cosmic" time. The implications of general relativity within the models studied, and the power of general relativity in cosmology as a whole, are demonstrated. (T.F.H.)

12828 THE PROSPECTS FOR ALTERNATING CURRENT MAGNETOHYDRODYNAMIC POWER GENERATION. R. B. Clark, D. T. Swift-Hook, and J. K. Wright (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Brit. J. Appl. Phys., 14: 10-15(Jan. 1963).

The various possible systems of a-c magnetohydrodynamic power generation using electrodes or inductive coupling with stationary or alternating magnetic fields are examined and compared with the d-c case. It is shown that with gas temperatures below 3000°K and an alternating magnetic field the cost of coil driving equipment is likely to be prohibitive, while theoretical and experimental evidence suggests that the inductive coupling and a steady magnetic field the power densities are probably too low to be of interest. The only possibility remaining is the generator with pulsed conductivity where the current is collected on electrodes. The considerable difficulties peculiar to this method are discussed. (auth)

12829 ON THE APPLICATION OF ASTON BANDS AND APPEARANCE POTENTIAL MEASUREMENTS TO ION COLLISION STUDIES. William McGowan and Larkin Kerwin (Université Laval, Quebec). Can. J. Phys., 41: 316-42 (Feb. 1963).

Two techniques are applied to ion collision studies. The first (Aston banding) effectively makes of a simple mass analyzer a double mass spectrometer, which separates unambiguously the parent ions from the products. By combining with the mass spectrometer a "high-pass" energy filter, ionic collisions can be studied that take place in the drift regions both before and after the magnetic analyzer. Methods are described for measuring total cross sections for both charge exchange and collision-induced dissociation, as well as the loss and distribution of energy and momentum of the high-velocity product ions. The accelerating potential range for the ion collisions is 0.6 to 2.0 kv. The second technique is the detailed comparison of appearance potential (A.P.) curves. From the ratio of the A.P. curve of the product to that of the parent, a method is shown for determining directly the influence of metastable or long-lived excited ions in the parent ion beam. It is shown how, from the ratio of the differences of slopes, the relative (and sometimes absolute) cross sections associated with these ionic states that enter into collision with a particular ion kinetic energy, can be determined. The techniques and the conditions under which they are applicable are stressed. (auth)

12830 JOULE HEAT EFFECTS IN SUPERCONDUCTING ELECTROMAGNETS. C. K. Campbell and D. G. Walmsley (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 416-19(Feb. 1963).

A superconducting electromagnet is described in which all junctions between normal and superconducting metals are cooled by the use of Cu cooling fins. Cooling is effected in order to inhibit the joule heating of the superconductor; this joule heating causes the progressive destruction of the superconducting state along the wire. The joule heating is analyzed in terms of traveling temperature waves. The experimental and calculated values for the current at which destruction of the superconducting state just starts are calculated. (T.F.H.)

12831 GROUND MULTIPLET OF THE ARC SPECTRUM OF PLUTONIUM. Jean Blaise, Mark Fred, Simon Gerstenkorn, and Brian R. Judd (Centre National de la Recherche Scientifique, Bellevue, France). Compt. Rend., 255: 2403-5 (Nov. 5, 1962). (In French)

The structure of the ground multiplet $5f^6\ 7s^2(^7F)$ of the arc spectrum of Pu and the values of Lande factors were determined. The comparison of the experimental results with the theoretical values is satisfactory. The hyperfine structures and the isotopic displacements of different levels of the multiplet were measured. (tr-auth)

12832 QUADRUPOLE AND FORBIDDEN TRANSITIONS IN THE L SPECTRA OF HEAVY ELEMENTS: TUNGSTEN, RHENIUM, AND LEAD. Bhaskar Gangadhar Gokhale and Kripa Shanker Srivastava. Compt. Rend., 255: 2406-7(Nov. 5, 1962). (In French)

New quadrupole or forbidden transitions were observed in the L spectra of the heavy elements W, Re, and Pb, using a 40-cm curved crystal mica spectrograph. Some old measurements were made more precise. (tr-auth)

12833 STUDY OF THE POSITION AND LENGTH OF THE NUCLEAR MAGNETIC RESONANCE RAY CHARACTERISTIC OF THE H_2 MOLECULE. Marcel Chaigneau, Elie Dayan, and Gérard Widenlocher (Centre National de la Recherche Scientifique, Bellevue, France and Centre National de la Recherche Scientifique, Paris). Compt. Rend., 255: 2597-9(Nov. 12, 1962). (In French)

The measurements made on the position and length of the H_2 molecule (nuclear magnetic resonance) for which divergences exist between theoretical calculations and previous experimental results are described. The value of the chemical displacement ($\delta = 4.13$) is confirmed, and the very large length of the H_2 ray is made more precise. (tr-auth)

12834 THERMAL INTERFACE LAYER IN A FLAT PLATE IN ANISOTROPIC MAGNETOHYDRODYNAMICS. B. B. Baranov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Mekhan. i Mashinostr., No. 6, 3-5(Nov.-Dec. 1962). (In Russian)

Equations were developed for calculating boundary layer flow of incompressible gas on a flat plate in the presence of a magnetic field parallel to the plate and the incoming stream. (R.V.J.)

12835 CONDUCTING FLUID FLOW AT THE ENTRANCE OF A PLANE CHANNEL. S. A. Regirer. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk., Mekhan. i Mashinostr., No. 6, 6-9 (Nov.-Dec. 1962). (In Russian)

A generalized solution was found for arbitrary laminar magnetohydrodynamic flow of viscous incompressible fluid at the entrance of a channel with semi-infinite walls in the presence of a two-dimensional magnetic field. (R.V.J.)

12836 APPLICATION OF SPACE-GROUP THEORY TO THE VIBRATIONAL PROBLEM OF DI-TETRAMETHYL AMMONIUM URANIUM HEXACHLORIDE. S. A. Pollack (Space Tech. Labs., Inc., Los Angeles). J. Chem. Phys., 38: 98-108(Jan. 1, 1963).

The absorption spectrum of $[(CH_3)_4N]_2UCl_6$ (TMA) is discussed. The spectrum is vibronic in nature, that is, the electronic transitions between levels belonging to the $5f^2$ configuration of the U^{4+} ion are coupled with the vibrations of the TMA lattice. The number and symmetries of the normal modes of vibration of a unit cell were calculated in the factor group approximation. The Winston-Halford decomposition formula was used to reduce the representation of motions among the irreducible representations of the symmetry group of TMA. Calculations were compared with the experimental results. The gross features of the spectrum were found to be in agreement with the theoretical predictions. The method of obtaining the character tables for finite symmorphic space groups is presented in summary form. A general vibrational problem in crystals is also discussed. (auth)

12837 EFFECTS OF N^{15} ON THE NUCLEAR QUADRUPOLE RESONANCE OF N^{14} IN SOLID N_2. Paul J. Haigh and Thomas A. Scott (Univ. of Florida, Gainesville). J. Chem. Phys., 38: 117-21(Jan. 1, 1963).

When solid N_2 is enriched with N^{15} ($I = 1/2$) the N^{14} resonance is split into two distinct lines. For an approximately equal isotopic mixture, the splitting is 8.2 kC at 4.2°K and decreases with increasing temperature. Using the Bayer-Kushida theory as a basis, the two resonance frequencies may be attributed to the presence of two types of molecules $N^{14}-N^{14}$ and $N^{14}-N^{15}$. The former molecule has a resonance frequency close to that of pure N_2^{14} whereas the latter molecule, being heavier and thus vibrating with a smaller amplitude, has the higher frequency. The data are discussed on the basis of present theoretical and experimental understanding. (P.C.H.)

12838 ABSORPTION SPECTRUM OF Pu^{3+} IN LANTHANUM TRICHLORIDE AND LANTHANUM ETHYLSULFATE. Hildelore Laemmermann and John G. Conway (Univ. of California, Berkeley). J. Chem. Phys., 38: 259-69(Jan. 1, 1963). (UCRL-10257)

The polarized absorption spectrum and some Zeeman effect studies were conducted on crystals of lanthanum trichloride and lanthanum ethylsulfate containing 0.1 and 5 mole % of Pu^{3+} at various low temperatures. The ground-state levels as well as several excited states are well characterized. Attempts at fitting the positions of levels of $5f$ hydrogenic free-ion states give good agreement for $F_2 = 245$ cm^{-1} and $\zeta = 2290$ cm^{-1}. (auth)

12839 DIFFERENTIATED SCHRÖDINGER EQUATION. Joseph C. Y. Chen (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 38: 283-4(Jan. 1, 1963). (BNL-6390)

It is shown that the generalized Hellmann-Feynman (H-F) theorem and formulas for evaluating an infinite sum can be obtained from a unified matrix equation derived from the differentiated Schrödinger equation. Some consequences and applications of the matrix equation are also discussed. (P.C.H.)

12840 MEAN FIRST-PASSAGE TIMES AND THE DISSOCIATION OF DIATOMIC MOLECULES. Kurt E. Shuler (Inst. for Defense Analyses, Washington, D. C.) and George H. Weiss. J. Chem. Phys., 38: 505-9(Jan. 15, 1963).

The collisional activation of diatomic molecules to dissociation can be considered as a random walk with an absorbing barrier in the energy space of the molecules. In such a model, the rate of activation to dissociation is related to the mean first-passage time of the molecules across the absorbing barrier. The mean first-passage time was computed for an ensemble of oscillators in an initial Boltzmann distribution with transitions limited to nearest-neighbor states ($|\Delta v| = 1$) and for an ensemble of oscillators initially in the ground state ($v = 0$) which undergo transitions between nonnearest-neighbor states ($|\Delta v| \geq 1$). It is shown that the magnitude of the mean first-passage time is very sensitive to the height (in energy space) of the absorbing barrier and to the "jump distance," $|\Delta v| > 1$, for nonnearest-neighbor transitions. The implications of these results on the mechanism of the activation and dissociation of diatoms are discussed briefly. (auth)

12841 HIGH-VELOCITY MOLECULAR BEAM SCATTERING: TOTAL ELASTIC CROSS SECTIONS FOR L-J(n,6) AND EXP-6(α) POTENTIALS. Richard B. Bernstein (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 38: 515-22(Jan. 15, 1963).

Explicit expressions are derived for the total elastic scattering cross sections in the high-velocity region for molecules interacting according to L-J(n,6) and exp-6(α) potentials. Cross sections are presented in tabular and graphical form. (auth)

12842 PERTURBED HARTREE-FOCK CALCULATIONS. I. MAGNETIC SUSCEPTIBILITY AND SHIELDING IN THE LiH MOLECULE. R. M. Stevens, R. M. Pitzer, and W. N. Lipscomb (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 38: 550-60(Jan. 15, 1963).

The limited basis set Hartree-Fock problem is solved in the presence of a perturbation term in the Hamiltonian to obtain the first-order perturbed wave function. The formulation is applied to the calculation of electric polarizability, magnetic susceptibility, and magnetic shielding. The effect of the limited basis set on the gauge invariance of the mag-

netic quantities is discussed. The magnetic susceptibility and shielding, the rotational magnetic moment, and the spin rotational constants are calculated for lithium hydride using two different wavefunctions. The agreement with experiment is reasonably good for the spin rotational constants and rotational magnetic moment. It is felt that further refinement of the calculation would not change the results by more than a few percent. (auth)

12843 FLUORESCENCE DECAY TIMES OF RARE-EARTH CHELATES. M. L. Bhaumik, H. Lyons, and P. C. Fletcher (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Chem. Phys., 38: 568-9(Jan. 15, 1963).

The fluorescence lifetimes of trivalent Sm, Eu, and Tb were measured in their pure salts and in chelates with benzoylacetonate, acetylacetonate, and dibenzoylmethide. The decay times in the chelates are much longer than those in the salts, and several possible explanations of this effect are discussed. (D.L.C.)

12844 ONE-CENTER WAVEFUNCTION FOR THE HYDROGEN MOLECULE ION. T. J. Houser, P. G. Lykos, and E. L. Mehler (Illinois Inst. of Tech., Chicago). J. Chem. Phys., 38: 583-6(Feb. 1, 1963).

An examination of the one-center, noninteger principal quantum number, Slater-type orbital representation applied to the hydrogen molecule ion is presented. The results give rapid convergence to the experimental value for the total electronic energy. A value of −1.09770 a.u. is obtained using only five terms in the expansion. This is 0.00207 a.u. closer to the experimental value than the fifteen-term Howell and Shull calculation. The limiting energy which can be obtained using only s-type terms agrees with the Howell and Shull estimate. (auth)

12845 MOMENT EQUATIONS FOR VIBRATIONAL RELAXATION COUPLED WITH DISSOCIATION. S. P. Heims (Brandeis Univ., Waltham, Mass.). J. Chem. Phys., 38: 603-6(Feb. 1, 1963).

Sets of equations for the moments of the vibrational energy distribution for a diatomic species in a gas are derived, considering simultaneous dissociation and vibrational relaxation. In the first approximation a set of two coupled equations are obtained, one for the number of diatomic molecules and the other for the vibrational energy per molecule. The latter contains two correction terms to the Bethe-Teller equation, due to the coupling. The next higher approximation gives three coupled equations, in which the second moment (dispersion) of the distribution function is taken into account. In these equations the dissociation rate "constant" is a function of both the average vibrational energy and the second moment. The recombination process is described by three constants which define the overall rate, the average vibrational energy, and the dispersion about the average energy of just recombined molecules. The starting point in the development is a gain-loss equation for occupation numbers of vibrational levels. The assumption of harmonic vibrations is used. In order to close the set of equations in any order of approximation, those terms involving higher moments are determined by application of a general method due to Jaynes which gives the least biased estimate in view of the information contained in the moments considered. Consideration of the steady state in first approximation leads to Onsager reciprocal relations and, in second approximation, to more complicated relations. (auth)

12846 INFRARED ABSORPTION SPECTRA OF LiF AND Li_2F_2 IN SOLID ARGON, KRYPTON, AND XENON MATRICES. Milton J. Linevsky (General Electric Co., King of Prussia, Penna.). J. Chem. Phys., 38: 658-61 (Feb. 1, 1963).

The infrared absorption spectra of LiF and Li_2F_2 isolated in solid argon, krypton, and xenon were investigated from 2 to 35 μ. Infrared frequencies of both molecules were obtained, and the assignment of the B_{2u} and B_{3u} modes of Li_2F_2 was made assuming a planar rhomboid structure, (V_h). An interesting case of a so-called "matrix effect" is also presented. (auth)

12847 NUCLEAR MAGNETIC RESONANCE STUDY OF THE PHASE TRANSITION IN STRONTIUM TITANATE. M. J. Weber and R. R. Allen (Raytheon Research Div., Waltham, Mass.). J. Chem. Phys., 38: 726-9(Feb. 1, 1963).

The nuclear magnetic resonances of Sr^{87}, Ti^{47}, and Ti^{49} in a single crystal of $SrTiO_3$ were studied in the vicinity of the phase transition at 110°K. The Sr^{87} resonance exhibited line broadening and a gradual decrease in amplitude below 110°K. This is attributed to quadrupole interactions arising from a noncubic crystalline field and is in agreement with electron paramagnetic resonance experiments. No change in the titanium resonance was observed upon cooling the crystal to the lowest available temperature of 95°K. From estimates of the quadrupole coupling constants, the results suggest that the ionic displacements are small and very little distortion of the titanium–oxygen octahedra occurs during the structural phase transition in $SrTiO_3$. (auth)

12848 VALIDITY OF THE WKB APPROXIMATION IN THE INTERPRETATION OF MOLECULAR BEAM SCATTERING DATA. R. P. Marchi and C. R. Mueller (Purdue Univ., Lafayette, Ind.). J. Chem. Phys., 38: 740-4(Feb. 1, 1963).

The validity of several approximations pertinent to molecular scattering was investigated. The WKB method was found to be reliable and was used to demonstrate the sensitivity of molecular scattering data to the intermolecular potential. (auth)

12849 WKB ANALYSIS OF MOLECULAR BEAM SCATTERING AND THE LENNARD-JONES POTENTIAL. C. R. Mueller and R. P. Marchi (Purdue Univ., Lafayette, Ind.). J. Chem. Phys., 38: 745-8(Feb. 1, 1963).

The WKB method was used in the interpretation of molecular beam scattering. Particular attention was given to small-angle scattering where the sensitivity to the intermolecular potential is greatest. It was found that the Lennard-Jones potential does not fit the data and that, for the case investigated, the minimum in the potential probably needs to be broadened. Empirical relationships between the phase shifts and the intermolecular potential were found which should be of value in the inversion problem. A calculation of rainbow scattering was made. (auth)

12850 CONCENTRATIONS IN A MOLECULAR BEAM AND THE FIRST INVERSE MOMENT OF THE DISTRIBUTION OF MOLECULAR SPEEDS IN THE BEAM. William J. Taylor (Ohio State Univ., Columbus). J. Chem. Phys., 38: 779-80(Feb. 1, 1963).

The ratio of the concentration of a gaseous molecular species at a given point in the beam to that in the gas from which the beam issues, is determined by a purely geometrical factor. Hence, the mole fraction of each species has the same value at any point in the beam that it has in the gas. A theorem on the first inverse moment of the distribution function for molecular speeds is derived, and the geometrical factor is shown to be a $\cos\theta/4\pi r^2$, where a = orifice area. Thus, the concentration at an axial point could be greatly increased by making the orifice in the form of a thin annulus and using an annular slit of smaller

radius to define a beam in the form of a conical sheet converging at the point. (D.L.C.)

12851 BURSTING OF ELECTRON BEAMS WITH ELECTRON TRAPPING. M. J. Kofoid and H. V. Cleva (Boeing Scientific Research Labs., Seattle). J. Electron. Control (1), 13: 525-8(Dec. 1962).

Beam bursting was produced with two independent oppositely directed electron beams which interpenetrated. The directed energy is converted into fluctuation energy. This occurs when the beams are injected, with low velocities, into a potential well caused to exist between the beam-emitting electrodes. In the well, acceleration of the beam electrons and a trapping of a fraction of them takes place. Beam bursting can be produced only with such gas densities, and only in gases with sufficiently low electron temperatures, that standing waves of longitudinal electron oscillations can be excited. Particular combinations of beam currents and well potentials are required. The bursting phenomenon and the electron oscillations occur together. With critically adjusted conditions, tunable ion-oscillation frequencies can be excited; simultaneously the electron oscillations fall to a very low value. (auth)

12852 OBSERVATIONS OF SYNCHROTRON RADIO NOISE AT THE MAGNETIC EQUATOR FOLLOWING THE HIGH-ALTITUDE NUCLEAR EXPLOSION OF JULY 9, 1962. G. R. Ochs (National Bureau of Standards, Boulder, Colo.), D. T. Farley, Jr., K. L. Bowles, and P. Bandyopadhay. J. Geophys. Res., 68: 701-11(Feb. 1, 1963).

This paper describes the results of radio measurements made in Peru of synchrotron radiation at 30 and 50 Mc/s. This radiation was produced by relativistic electrons injected into trapped orbits in the earth's magnetic field during the high-altitude nuclear explosion of July 9, 1962. A preliminary interpretation of these results is also given. At 50 Mc/s there was a brief transient increase in the antenna temperature of 4.5×10^{4}°K shortly after the explosion. This can be compared to the normal antenna temperature at that time of 5.5×10^{3}°K. The excess temperature soon decreased to about 1×10^{4}°K and has since decayed only very slowly from this value, the time constant being about two months. From the early transient changes in the antenna temperature, a fairly accurate description of the energy distribution of the electrons is obtained. This spectrum is found to vary almost exactly as the fission spectrum, $\exp(-0.575E - 0.055E^2)$, in the range $1 \leq E \leq 5$, where E is the kinetic energy in Mev. Above 5 Mev the spectrum falls off somewhat faster than this expression, but the measurements are rather poor in this range. The value 2×10^{24} is obtained as a rough estimate of the total number of electrons having energies of the order of 1 Mev or greater that were trapped after the explosion. (auth)

12853 MEASUREMENTS OF SYNCHROTRON RADIATION AT CENTRAL PACIFIC SITES. R. B. Dyce (Stanford Research Inst., Menlo Park, Calif.) and S. Horowitz. J. Geophys. Res., 68: 713-21(Feb. 1, 1963).

Absorption-measuring devices called riometers were operated during the 400-km, 1.45-MT nuclear detonation over Johnston Island at 09h 00m 09s UT on July 9, 1962. A by-product of these measurements was the observation of strong synchrotron radiation from the relativistic electrons trapped in the artificial radiation belt. This paper discusses the experimental observations of synchrotron radiation primarily obtained by means of the Central Pacific riometers, although some data are included from routinely-operated observatories at other locations near the magnetic equator. The time-history of this radiation is traced, beginning with a strong burst of radiation for a few minutes over the Central Pacific. Beginning ten minutes later, the original intense tube of emitting electrons appeared again over the Central Pacific, having completed one trip around the globe, and showing signs of the dispersion in longitude caused by the spread in energy of the trapped electrons. The latitude, frequency, and long-term time dependence of the radio energy have been determined. The power falls to half-value at 12° from the magnetic equator and varies as f^{-3} in the frequency range from 30 to 120 Mc/s; after the first two weeks, it decays slowly with a half-life slightly in excess of 60 days. (auth)

12854 SYNCHROTRON RADIATION FROM HIGH-ENERGY ELECTRONS. Allen M. Peterson (Stanford Univ. and Stanford Research Inst., Calif.) and Glen L. Hower. J. Geophys. Res., 68: 723-34(Feb. 1, 1963).

The general characteristics of synchrotron radiation from high-energy electrons trapped in the earth's magnetic field are discussed, and methods are developed for calculating the radio noise that will be received at the ground. The synchrotron radiation from trapped electrons created by the nuclear explosion of July 9, 1962, is calculated. These calculations, based on electron flux density measurements in satellites, agree well with observations made at several radio frequencies in the 20-100 Mc/s frequency range at stations near the magnetic equator. It is concluded that the observed radio noise is generated primarily at heights above the magnetic equator between 1.2 and 1.6 earth radii and that it is a very insensitive measure of electrons moving at heights above about 1.6 earth radii becuase of the weak magnetic field at these heights. (auth)

12855 WHISTLER AND OTHER VERY LOW FREQUENCY PHENOMENA ASSOCIATED WITH THE HIGH-ALTITUDE NUCLEAR EXPLOSION ON JULY 9, 1962. G. Mck. Allcock (Dominion Physical Lab., Lower Hutt, New Zealand), C. K. Branigan, J. C. Mountjoy, and R. A. Helliwell. J. Geophys. Res., 68: 735-9(Feb. 1, 1963).

VLF phenomena observed near Wellington, New Zealand, after the nuclear explosion of July 9, 1962, include the occurrence of an explosion-excited whistler, evidence of high ionospheric absorption around New Zealand, and a remarkably transient effect on the propagation of VLF radio waves near the explosion area. A reduction in electron content of the exosphere may also have occurred. (auth)

12856 HIGH-LATITUDE IONIZATION ASSOCIATED WITH THE JULY 9 EXPLOSION. R. P. Basler (Geophysical Inst., College, Alaska), R. B. Dyce, and H. Leinbach. J. Geophys. Res., 68: 741-3(Feb. 1, 1963).

Prompt ionization of the lower ionosphere over Alaska followed the detonation of a high-altitude nuclear device on July 9, 1962. This ionization was evidenced by a moderate (1.5- to 3.5-db) increase of ionospheric absorption of 30-Mc/s cosmic radio noise at stations between geomagnetic latitudes of 63 and 67° north, and geomagnetic longitudes of 242 and 256° east. Onset of the absorption was delayed by less than 2 seconds at a geomagnetic latitude of 64.5° (L = 5.5) and a magnetic longitude only slightly removed from that of the detonation of the device. (auth)

12857 VERY LOW FREQUENCY DISTURBANCES AND THE HIGH-ALTITUDE NUCLEAR EXPLOSION OF JULY 9, 1962. A. J. Zmuda, B. W. Shaw, and C. R. Haave (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 68: 745-58(Feb. 1, 1963).

On July 9, 1962, a 1.4-megaton nuclear device was exploded at an altitude of 400 km above Johnston Island in the central Pacific. The burst perturbed the relative phase of three frequency-stabilized VLF transmissions on propagation paths shielded by the earth from the direct effects of

the explosion. The temporal variations of these three disturbances differ in major respects. On the NPG, Jim Creek, Washington, to APL/JHU path, the onset and maximum were essentially instantaneous, a characteristic which generally fits the burst-related neutron-decay model of Crain and Tamarkin in which sudden ionization in the VLF altitude region is produced by neutron-decay electrons geomagnetically guided into the lower ionosphere. In addition, the NPG-APL variation shows a secondary perturbation having a 10 second period and stemming from a hydromagnetic disturbance associated with temporarily trapped neutron-decay protons of 0.4 Mev. In contrast to the NPG-APL perturbation, and among other differences, the perturbations to the transmissions from NBA (at Balboa, Panama) and WWVL (at Boulder, Colorado) are marked by a delay in the onset and maximum. The disturbance observed for the NBA-APL path, which lies almost along a geomagnetic meridian, results from ionization of the lower ionosphere by electrons that were produced in the radioactive decay of fission fragments and that formed an artificial radiation belt. Here there is good qualitative agreement between the temporal variation of the VLF perturbation and the energy contained in the stream of trapped fission-decay electrons drifting azimuthally from the burst region over Johnston Island to the NBA area. The temporal VLF phase variation for the WWVL-APL path (which lies along a line of nearly constant geomagnetic latitude) indicates that the major part of this perturbation is due to ionization resulting from the effects of geomagnetically trapped neutron-decay electrons. A relatively early and small part of this disturbance also results from the contribution of trapped fission-decay electrons. (auth)

12858 EFFECT OF THE JOHNSTON ISLAND HIGH-ALTITUDE NUCLEAR EXPLOSION ON THE IONIZATION DENSITY IN THE TOPSIDE IONOSPHERE. P. Rothwell, J. H. Wager, and J. Sayers (Univ. of Birmingham, Eng.). J. Geophys. Res., 68: 947-9(Feb. 1, 1963).

Direct measurements of the effect of high-altitude nuclear explosions on ionization density above the F_2 layer were reported. The Birmingham RF electron density probe carried in satellite Ariel monitored the ambient electron density. Three possibilities were offered for the ionization detected. It was probably produced by energetic electrons injected into the trapped orbits above Johnston Island or particles dumped from the outer radiation zone by the magnetic disturbance created by the bomb. A further possibility was that this ionization originated in the diamagnetic bubble of hot gas from the fireball of the bomb. (C.E.S.)

12859 TELLURIC CURRENT MICROPULSATION BURSTS. R. R. Heacock and V. P. Hessler (Univ. of Alaska, College). J. Geophys. Res., 68: 953-4(Feb. 1, 1963).

Spectral similarity between the burst of telluric current micropulsations produced at College by the July 9, 1962, thermonuclear blast in the South Pacific and many natural bursts of telluric current micropulsations recorded at College was discussed. (C.E.S.)

12860 ON INTERMOLECULAR LENNARD-JONES POTENTIAL ENERGY PARAMETERS FOR RADON. Ram Gopal (Lucknow Univ., India). J. Indian Chem. Soc., 39: 791-2(Nov. 1962).

The parameters ϵ/k and σ of the Lennard-Jones potential energy function are calculated for the radon molecule. The latent heat of sublimation of solid radon at 0°K is calculated to be 4850 cal, and from this value, the parameter ϵ/k = 283°K is derived. The parameter σ is shown to have the probable value 4.36 A. Both parameter values agree with those estimated by Miller. (D.L.C.)

12861 A UNIFIED VARIATIONAL FORMULATION OF CLASSICAL AND QUANTUM DYNAMICS. [PART] I. Edward M. Corson (Georgetown Univ., Washington, D. C.). J. Math. Phys. (N. Y.), 4: 42-4(Jan. 1963).

The role and status of Lagrangian concepts in both classical and quantal contexts were critically re-examined. A new, unified variational principle was found which, subject to the superadded postulates of determinism or indeterminism, respectively, leads uniquely to the classical concept of state and Lagrange equations of motion or to the quantal concept of state and Schrödinger equations of motion. (auth)

12862 COMPLEX SCALAR FIELD IN GENERAL RELATIVITY. A. Das (Jadavpur Univ., Calcutta). J. Math. Phys., (N. Y.), 4: 45-51(Jan. 1963).

Complex scalar fields are introduced in general relativity to describe charged, gravitating particles with zero spin. A class of exact solutions of the combined Maxwell-Einstein-Klein-Gordon field equations is found that may represent complete models of matter. One of the models discussed is spherically symmetric and the remaining class does not assume any specific symmetry. Such exact solutions are possible only if the mass parameter equals the charge parameter in magnitude, so that physically speaking, matter is in equilibrium under the mutual action of electromagnetic and gravitational forces. (auth)

12863 THE LINE SHAPE IN A HARMONIC LATTICE. Robert Englman (Massachusetts Inst. of Tech., Cambridge) and Peretz Levi. J. Math. Phys. (N. Y.), 4: 105-15(Jan. 1963).

A general formalism is developed for the treatment of lattice vibrations. The problem is reduced to the mathematics of noncommuting operators. Hausdorff's equation is then solved for a lattice interacting with linear forces. The cases treated in detail are the line shapes of a radiating atom as affected by the displacement (Franck-Condon effect) and by the nuclear recoil (Mössbauer effect). Only formal results are obtained, which are more difficult to compute than those of the method of normal modes. However, they are more general and do not require the data of vibrational frequencies. (auth)

12864 STATISTICAL THERMODYNAMICS OF NONUNIFORM FLUIDS. J. L. Lebowitz (Yeshiva Univ., New York) and J. K. Percus. J. Math. Phys. (N. Y.), 4: 116-23 (Jan. 1963).

A general formalism was developed for obtaining the low-order distribution functions $n_q(r_1, \cdots, r_q)$ and the thermodynamic parameters of nonuniform equilibrium systems where the nonuniformity is caused by a potential U(r). Our method consists of transforming from an initial (uniform) density n_0 to the final desired density n(r) via a functional Taylor expansion. When n_0 is chosen to be the density in the neighborhood of the r's we obtain n_q as an expansion in the gradients of the density. The expansion parameter is essentially the ratio of the microscopic correlation length to the scale of the inhomogeneities. Our analysis is most conveniently done in the grand ensemble formalism where the corresponding thermodynamic potential serves as the generating functional [with U(r) as the variable] for the n_q. The transition from U(r) to n(r) as the relevant variable is accomplished via the direct correlation function which enters very naturally, relating the change in U at r_2 due to a change in n at r_1. It is thus essentially the matrix inverse of the two-particle Ursell function. The recent results of Stillinger and Buff on the thermodynamic potentials for nonuniform systems follow as a special case of our analysis without any recourse to the virial expansion. Thus, they hold also in the liquid region. In a succeeding paper

we apply our analysis to obtain the asymptotic behavior of the radial distribution function in a uniform system. (auth)

12865 PERPENDICULAR SUSCEPTIBILITY OF THE ISING MODEL. Michael E. Fisher (King's Coll., London). J. Math. Phys. (N. Y.), 4: 124-35(Jan. 1963).

A high-temperature expansion of the partition function for a lattice of N spins with Hamiltonian $\mathcal{H} = -J \sum_{(ij)} \sigma_i^z \sigma_j^z - mH_z \sum_i \sigma_i^z - mH_x \sum_i \sigma_i^x$ is derived and thence an expansion for the zero-field perpendicular susceptibility is found. By perturbation theory, $\chi_\perp(T)$ is also expanded at low temperatures and seen, in general, to increase with T from the value $\chi_\perp(0) = Nm^2/q\,|J|$, where q is the coordination number of the lattice. The perpendicular susceptibility is re-expressed in terms of near neighbor pair and higher-order spin correlation functions in zero field. This yields exact closed formulas for the linear chain, the Bethe pseudo-lattices, and for the plane square and honeycomb lattices. The behavior of $\chi_\perp(T)$ in the critical region is investigated for these lattices and for the plane superexchange lattice. (auth)

12866 QUATERNIONIC REPRESENTATIONS OF COMPACT GROUPS. D. Finkelstein (Yeshiva Univ., New York), J. M. Jauch, and D. Speiser. J. Math. Phys. (N. Y.), 4: 136-40(Jan. 1963).

Conditions are shown under which a finite dimensional representation of a group, irreducible over the complex field, is reducible over quaternions. The answer is simply stated in terms of the Frobenius-Shur classification of group representations. (auth)

12867 UNIQUENESS AND EXISTENCE OF THE SOLUTION TO THE STATIC LONDON-MAXWELL EQUATIONS IN TWO DIMENSIONS. Farouk Odeh (International Business Machines Corp., Yorktown Heights, N. Y.). J. Math. Phys. (N. Y.), 4: 141-6(Jan. 1963).

A theorem is given for the existence and uniqueness of the time-independent solution of the exterior-interior problem associated with determining the distribution of superconducting current, according to the London model, in simply- or doubly-connected two-dimensional regions. The proof of the corresponding theorem in three dimensions is outlined. A discussion is also given of the relationship between two "different" solutions which already exist for rectangular regions. (auth)

12868 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM, KYOTO, 4-15 SEPTEMBER, 1961. VOLUME I. EARTH STORM. J. Phys. Soc. Japan, 17: Suppl. A-I, 1-337(Jan. 1962).

Volume I includes 79 papers on the topics of morphology of magnetic storms, disturbances in polar regions, theories of magnetic storms and aurorae, aurora and airglow including auroral x-rays, ionospheric disturbances, and summary of the disturbances in the ionospheric regions. Four opening addresses are also included. Separate abstracts have been prepared for 7 papers. (M.P.G.)

12869 THE DETECTION AND STUDY OF SOLAR COSMIC RAYS BY RADIO TECHNIQUES. D. K. Bailey (National Bureau of Standards, Boulder, Colo.). J. Phys. Soc. Japan, 17: Suppl. A-1, 106-12(Jan. 1962).

Three distinct radio techniques have thus far been extensively used in the study of polar-cap absorption events (PCA's). PCA's represent a major ionospheric phenomenon resulting from the existence of a low-energy tail of the rather steep spectra of solar cosmic rays ejected from time to time from active solar regions. The most important energy range is from about 30 to 300 Mev. PCA's are much more common than would be surmised if knowledge of them rested solely upon the occurrence of sharp increases in ground-level cosmic-ray intensity relative to normal background. The techniques, which to be of greatest use must be employed in geomagnetic latitudes greater than 65° to 70°, are a study of f_{min} behavior from ionosonde observations, use of riometers, and a study of field-strength variations of VHF waves scattered obliquely from the lower ionosphere. Each technique supplies somewhat different information. The advantages and limitations of each are discussed. (auth)

12870 THE RING CURRENT AND A NEUTRAL LINE DISCHARGE THEORY OF THE AURORA POLARIS. Syun-ichi Akasofu (Univ. of Alaska, College) and Sydney Chapman. J. Phys. Soc. Japan, 17: Suppl. A-I, 169-73(Jan. 1962).

The electric current intensity distribution and the magnetic field produced are calculated for a model ring current belt, centered at 6 earth radii, in the outer part of the outer radiation belt. The current, partly eastward though mainly westward, produces a pronounced dip of the magnetic field near the center of the belt, agreeing with Explorer VI observation. During magnetic storms, protons (50 ~ 500 kev) in the belt increase, perhaps by capture from solar streams carrying (tangled?) magnetic fields. The ring current increases, and at times reverses the earth's magnetic field near the center line of the belt. Neutral lines (H = 0) appear, of two kinds, X and O. Particles discharged through narrow strips close to one or more X lines produce diffuse arcs, single or multiple. Particles sporadically captured produce transient eastward electric fields along the X lines. Electrons are accelerated, a strong (but unstable) current flows along the X lines. This narrows the "escape" strips and increases the number and energy of the auroral electrons. The result is extremely thin and bright auroral curtains, with large scale folding and fine ray structure. Westward auroral electrojets are also explained. (auth)

12871 A MECHANISM TO ESTABLISH THE MAGNETIC STORM RING CURRENT. A. J. Dessler, W. B. Hanson, and E. N. Parker (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Phys. Soc. Japan, 17: Suppl. A-I, 178-83(Jan. 1962).

It is shown how hydromagnetic waves generated by the impact of solar plasma on the geomagnetic field may form shock waves in the magnetosphere and provide a means of creating the geomagnetic storm, main-phase, diamagnetic ring current. These shock waves should develop on the night side of the earth and heat the ambient protons (which constitute the normal protonosphere) to approximately the hydromagnetic-wave velocity (of the order of 500 km/sec). The transfer of hydromagnetic wave energy to the protons stresses the geomagnetic field and produces the geomagnetic-storm main phase; i.e., the kilovolt-energy protons form a diamagnetic current. The bombardment of the upper atmosphere by energetic hydrogen atoms from the decaying ring current and the possible change in the decay time-constant of the ring current through the sunspot cycle are discussed. (auth)

12872 PARTICLE PRECIPITATIONS AND GEOMAGNETIC STORMS. Tatsuzo Obayashi (Radio Research Labs., Japan). J. Phys. Soc. Japan, 17: Suppl. A-I, 201-4(Jan. 1962).

The behavior of high-energy particles from solar flares differs in the geomagnetic field depending on the energy of the particles. This information is used to study the geo-

magnetic field during magnetic storms. The precipitation patterns of solar particles during storms and the current systems of geomagnetic disturbances in the polar regions are discussed. (M.P.G.)

12873 LOW LATITUDE RED AURORA AND LOW ENERGY PROTONS IN VAN ALLEN BELT. Tadayoshi Hikosaka and Kyo Yano (Niigata Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-I, 233-6(Jan. 1962).

It is proved that the great intensity ratio of the red to the green line of O-atom accompanied by the strong emission of N_2^+ N.G. is a useful criterion to distinguish the aurora excited by a few kev protons from those of other origins. The red line enhancement is due to the low temperature of the electrons ejected by proton bombardment. The estimated temperature and the red-green ratio is 0.5, 1, 2.5 and 4 ev and 500, 45, 12 and 6.5 for protons of 1, 2, 5 and 25 kev, respectively. The efficiency of the red line excitation by the secondary electrons of 3 kev protons is estimated to be about one photon per one electron. If we take as a model of low latitude aurora the following: thickness 100 km, the red line brightness 10 kR at 250 km height and 1 kR at 600 km, and the red-green ratio 20, then the energy of the incident proton must be about 3 kev, and the necessary flux is $8 \times 10^8/cm^2$, sec at 250 km and $3 \times 10^{10}/cm^2$, sec at 600 km. This large increase of flux with height and many other evidences indicate that they come from Van Allen Belt. (auth)

12874 CHARGED PARTICLES IN THE EARTH'S MAGNETIC FIELD AND THE IONOSPHERIC F2 LAYER. P. Rothwell (Univ. of Birmingham, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-I, 263-70(Jan. 1962).

It is suggested that large fluxes of ionospheric electrons and protons spiral along magnetic lines of force of the earth's field to establish an equilibrium condition between the F2 layers of magnetic conjugate points in opposite hemispheres such that equal fluxes of ionized particles are found at both places. Several features of the behavior of the F2 layer can be explained on the basis of this hypothesis, and experimental observations of F2 layer critical frequencies provide evidence of the interdependence of the ionospheres at magnetic conjugate points. It is further suggested that the ionosphere may be an important source of electrons trapped in the Van Allen radiation belts, if ionospheric electrons of thermal energies travelling between hemispheres are accelerated and undergo changes in pitch angle during magnetic storms, like the higher energy trapped particles. (auth)

12875 INTERACTION OF TRAPPED RADIATION AND THE DS CURRENT SYSTEM. K. D. Cole (Department of External Affairs, Melbourne). J. Phys. Soc. Japan, 17: Suppl. A-I, 296-300(Jan. 1962).

The swollen atmosphere above electric currents in the ionosphere creates (by atmospheric scattering) a reservoir of geomagnetically trapped particles with lower than usual mirror points. Mirror points may be further lowered by kinking of F_m = constant surfaces produced by electric currents and hydromagnetic waves. Geomagnetically trapped particles may also be precipitated into the atmosphere by collision with (Doppler shifted) hydromagnetic waves. Auroral luminosity may be created thereby and also by King and Roach's mechanism in conjunction with joule heating by ionospheric electric current. Some auroral statistics are qualitatively explained using an average DS current system. (auth)

12876 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM, KYOTO, 4-15 SEPTEMBER, 1961. VOLUME II. JOINT SESSIONS. J. Phys. Soc. Japan, 17: Suppl. A-II, 1-625 (Jan. 1962).

Sessions are included on hydromagnetics, geomagnetic rapid variation, whistler and VLF emission, radiation belts, solar radiation (electromagnetic waves, particles), cosmic-ray modulation, interplanetary plasma, and synthetic theory of the earth storms. Separate abstracts have been prepared for most of the papers. (W.D.M.)

12877 HYDROMAGNETIC WAVES IN THE EXOSPHERE. Tomikazu Namikawa (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 1-5(Jan. 1962).

The reflection and refraction of hydromagnetic waves are studied at a plane boundary between two semi-infinite homogeneous media under a uniform (main) magnetic field. The results are applied to the propagation of hydromagnetic waves in the exosphere. The transverse wave propagates in a complicated way, depending on the direction of the main field with an anisotropic velocity, but the isotropic wave propagates in a simple way, independent of the direction of the main field, with an isotropic velocity. In the equatorial region, waves of both type propagate along the main field and cannot propagate directly to the lower atmosphere. (auth)

12878 HYDROMAGNETIC RADIATION OF THE SUN AND ITS EFFECT AT THE EARTH. K. D. Cole (Department of External Affairs, Melbourne). J. Phys. Soc. Japan, 17: Suppl. A-II, 6-9(Jan. 1962).

A theory is put forward to account for the steady background of geomagnetic disturbance. Hydromagnetic radiation continually split out of the sun or generated in the inner corona is suggested to be responsible for the bulk of geomagnetic disturbance. The transit time of disturbance from sun to earth is determined by the Alfvén speed in the space between. The theory suggests that the density of interplanetary gas (assumed fully ionized) is between 10 and 10^{-1} proton-electron pairs per cm^3. A characteristic wavelength equal to the dimensions of the sun would explain cosmic ray modulation in the manner suggested by Elliot. Such waves would be of a period 10 minutes. The waves can cause corpuscular bombardment of comets and planets. The earth environment acts as a hydromagnetic lens to radiation of a period less than 10 seconds and concentrates its energy to the central polar region (<80° latitude). Waves of longer period create winds of variable speed and direction about the earth. The earth's outer atmosphere constitutes an inhomogeneity in the path of the large hydromagnetic waves, and currents that would normally flow uninhibited in interplanetary space create a space charge distribution in the lower ionosphere. This can cause currents in the E regions contributing to geomagnetic disturbance. (auth)

12879 INFRASONIC PRESSURE WAVES ASSOCIATED WITH MAGNETIC STORMS. P. Chrzanowski, J. M. Young, G. Greene, and K. T. Lemmon (National Bureau of Standards, Washington, D. C.). J. Phys. Soc. Japan, 17: Suppl. A-II, 9-13(Jan. 1962).

Pressure waves with predominant periods between 20 and 80 seconds and amplitudes up to 8 dyne/cm^2 have been recorded with a quadrilateral microphone array near Washington, D. C., during intervals of high magnetic activity. These waves have a trace velocity along the earth's surface higher than the local speed of sound and show diurnal-directional properties consistent with a source on the night side of the earth. A high degree of association with large values of the planetary magnetic index K_p has been established. (auth)

12880 HYDROMAGNETIC PICTURE OF EARTH STORMS. A. J. Dessler (Physical Research Lab., Ahmedabad, India). J. Phys. Soc. Japan, 17: Suppl. A-II, 13-15(Jan. 1962).

A description of the principal features of magnetic storms has been given in other papers in these proceedings. Subsidiary topics not previously covered are discussed in some detail. (auth)

12881 THE INTERPLANETARY FIELD AND AURORAL THEORY. J. W. Dungey (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-II, 15-19(Jan. 1962).

Most of the theoretical work on auroral problems omits any interplanetary magnetic field. An attempt is made to predict what would happen if there were an approximately southward interplanetary field, and it is shown that the model appears to fit some of the observed phenomena. (W.D.M.)

12882 EQUATORIAL MICROPULSATIONS. V. Rosemary S. Hutton (Univ. of Ghana, Legon). J. Phys. Soc. Japan, 17: Suppl. A-II, 20-3(Jan. 1962).

Data previously reported from Legon, Ghana, earth current records were re-examined to determine (1) the dependence of the shape of the diurnal variation curve on the criteria used for pc (continuous sinusoidal pulsations with period 20-30s) detection, particularly with regard to the minimum amplitude considered, and (2) the daily variation of pc amplitude. (W.D.M.)

12883 PULSATIONS DURING SUDDEN COMMENCEMENTS OF MAGNETIC STORMS AND LONG PERIOD PULSATIONS IN HIGH LATITUDES. A. I. Ohl (Arctic and Antartic Inst., Leningrad). J. Phys. Soc. Japan, 17: Suppl. A-II, 24-6(Jan. 1962).

Analysis of the records of standard magnetographs obtained from 1956 to 1960 at the polar observatories of Tikhaya Bay, Cape Chelyuskin, Dixon Island, Cape Wellen, Tixie Bay, and at the middle latitude observatory Voyeikovo has shown that the regular geomagnetic pulsations usually observed are of the following types: common giant pulsations; long-period giant pulsations; and pulsations during sudden commencements. The last two types are discussed. (W.D.M.)

12884 MAGNETIC FIELD FLUCTUATIONS ON THE EARTH AND IN SPACE. N. F. Ness, T. L. Skillman, C. S. Scearce, and J. P. Heppner (National Aeronautics and Space Administration, Greenbelt, Md.). J. Phys. Soc. Japan, 17: Suppl. A-II, 27-33(Jan. 1962).

The recent development of rubidium vapor magnetometers as practical instruments for measuring magnetic fields has led to extremely precise and accurate determinations of magnetic fields on the earth and in space. Because of the unique manner in which the data are presented in the frequency domain, the data are very amenable to analysis by automatic digital computers. As a result, measurements of fluctuations of the terrestrial magnetic field have enabled accurate determinations of the frequency spectrum characteristics of the fluctuations. Magnetometer measurements of the field in space have been made from the space probe Explorer X launched March 25, 1961. The terrestrial measurements are continuous over intervals of several days. These data were sampled once per second. Power spectrum analyses have indicated distinct frequency bands in which the fluctuating magnetic field energy is concentrated. Data collected at the Fredericksburg Magnetic Observatory show a strong spectral peak for fluctuations with a period of around 10 seconds. These peaks are found to be both amplitude and frequency modulated on a daily basis. Additional spectral peaks have been observed and studied in the terrestrial data. The data obtained from measurements in space are less extensive at present. Hence, they do not allow sophisticated analyses to be performed as indicated above. Time correlations with terrestrial data have been made to study these fluctuations. The fluctuation of the field is then viewed with respect to the existence and propagation characteristics of hydromagnetic waves. (auth)

12885 MORPHOLOGICAL STUDY OF GEOMAGNETIC PULSATIONS. Yoshio Kato and Takao Saito (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: Suppl. A-II, 34-9(Jan. 1962).

Using the rapid-run and the ordinary magnetograms obtained during IGY, at the observatories distributed fairly well over the world, continuous pulsations of type I (range in period from 10 to 50 seconds), II (50-150 sec), and III (150-900 sec) are analyzed with pt-type pulsation. Type II pc shows remarkable enhancement in the daytime as type I pc, while type III pc has two vague maxima in the morning and the evening. The geomagnetic latitude is higher, the range of all three types of pulsations is larger, especially for type III pc, there is a sharp maximum in the auroral zone. For pt-type pulsation, its latitudinal dependence is compared with that of bay disturbance. The detail mode of world-wide synchronous oscillation according as the progress of pt shows that the direction of each oscillation is apt to point towards the midnight meridian in the northern or southern auroral zone. (auth)

12886 HYDROMAGNETIC WAVES IN THE EARTH'S EXOSPHERE AND GEOMAGNETIC PULSATIONS. Y. Kato and T. Tamao (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: Suppl. A-II, 39-43(Jan. 1962).

A qualitative discussion on the physical characters in the exosphere is given. Using the propagation equation of hydromagnetic waves (HM-waves) in the particular coordinates and assuming Johnson's model of the exosphere, refractive indices for downward propagation of external HM-waves with specified period and wave length in the lower latitudes are obtained as a function of altitudes. It is shown that HM-waves propagating to the perpendicular direction to lines of force will be reflected at the particular level corresponding to their period, and a part of their energy will be transported into the lower region (higher latitudes) by means of transverse waves propagating parallel to the line of force through this level. It is suggested that primary sources of daytime continuous pulsations are attributed to large amplitude HM-disturbances in the outermost exosphere. Since these disturbances may have considerable wide band width of spectrum, $T \simeq 1$ sec $\sim 3 \times 10^2$ sec, observed characteristics of daytime pulsations at the surface will be explained in terms of the filtering effect of the dispersive inner exosphere. It is also suggested that damped type pulsation, pt's, may be caused by the hydromagnetic compression of the local hot gas in the outer exosphere near the equatorial plane in the dark hemisphere, and this compression will occur as a result of the precipitation of trapped energetic electrons from this local region to the auroral zone. (auth)

12887 THE MICROSTRUCTURE OF ISc OF GEOMAGNETIC STORMS. Jan Bouška (Geophysical Inst., Czechoslovak Academy of Sciences, Prague). J. Phys. Soc. Japan, 17: Suppl. A-II, 45-7(Jan. 1962).

The sudden commencement of a geomagnetic storm Sc is one of the most important geomagnetic phenomena. Some

characteristics of the initial phase of a geomagnetic storm following immediately after Sc are investigated. (auth)

12888 GEOMAGNETIC RAPID VARIATIONS DURING IGY AND IGC. A. Romañá and J. O. Cardús (Observatorio del Ebro, Tortosa, Spain). J. Phys. Soc. Japan, 17: Suppl. A-II, 47-55(Jan. 1962).

Some results are presented which can be obtained with the monthly data sent to IAGA Com. 10 on Geomagnetic Rapid Variations for the period of IGY and IGC (July 1957–December 1959). The phenomena reported are: (1) pulsations (pt) and bays, (2) sudden commencements and sudden impulses, (3) solar flare effects, and (4) pulsations from rapid run magnetograms (pt and pc). (auth)

12889 CHARACTERISTICS OF GEOMAGNETIC PULSATIONS. J. A. Jacobs (Univ. of British Columbia, Vancouver). J. Phys. Soc. Japan, 17: Suppl. A-II, 55-63(Jan. 1962).

The classification of geomagnetic micropulsations is discussed, and the question is raised of a revision of the definitions of changes in the geomagnetic field over a much broader spectrum. An account is given of the research, both observational and theoretical, at present being carried out in the field of micropulsations at the Institute of Earth Sciences, University of British Columbia. (auth)

12890 FINE STRUCTURE OF MAGNETIC STORMS IN RESPECT TO MICROPULSATIONS (T < 20 SEC). V. A. Troitskaya, L. A. Alperovich, M. V. Melnikova, and G. A. Bulatova (Academy of Sciences, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-II, 63-70(Jan. 1962).

Results are given from fast-running earth current records at stations located in the Arctic, the Antarctic, and in the middle latitudes of the northern hemisphere. Pulsations with periods from fractions of a second to 15 to 20 seconds were analyzed. The results of processing of 30 magnetic storms are analyzed. The general state of the magnetic field during 48 hours before the storm was investigated. (W.D.M.)

12891 GEOMAGNETIC PULSATIONS AND HYDROMAGNETIC OSCILLATIONS OF EXOSPHERE. Yoshio Kata (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 17: Suppl. A-II, 71-3(Jan. 1962).

According to the morphological study of geomagnetic pulsation, they can be divided into two main classes, one is continuous pulsation (pc) and the other is pt pulsation. The characteristics of continuous pulsations are listed. (W.D.M.)

12892 CORRELATIONS BETWEEN THE VERY LOW FREQUENCY EMISSIONS AND THE MAGNETIC AND COSMIC RAY STORMS. Y. Corcuff and J. P. Legrand (Centre National de la Recherche Scientifique, Paris). J. Phys. Soc. Japan, 17: Suppl. A-II, 76-8(Jan. 1962).

At the latitude of Poitiers (49.5°N) VLF emissions, including hiss and chorus, are rather scarcely observed, but in close relation with the magnetic activity when K_p indexes are greater than 5. An attempt is made to correlate VLF emissions with magnetic and cosmic storms. (W.D.M.)

12893 THE DISTURBANCES OF EXOSPHERE AS SEEN FROM THE VLF EMISSION. S. Yoshida (Nagoya Univ., Japan) and T. Hatanaka. J. Phys. Soc. Japan, 17: Suppl. A-II, 78-83(Jan. 1962).

If VLF emissions propagate along the earth's magnetic lines of force, most of the VLF emissions will pass through the radiation belts. An attempt is made to compare the time variation of VLF emissions at different latitudes. This will give a clue towards solving the physical nature of the exosphere at different radial distances from the earth's surface. The VLF data used for the analysis were obtained at 19 stations. (W.D.M.)

12894 VLF PHENOMENA IN LOWER LATITUDES DURING MAGNETICALLY HIGH ACTIVE PERIODS. J. Outsu and A. Iwai (Nagoya Univ., Toyokawa, Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 88-91(Jan. 1962).

Using the IGY and IGC data of whistlers observed at Toyokawa and Wakkanai, variations of normalized occurrence rate and dispersions of whistlers have been statistically examined during periods of severe magnetic disturbances. It has been found that the rate begins to rise one day after the disturbed day and a raised level continues for about three days and the peak of rate is far greater for Toyokawa than for Wakkanai. Dispersions are found to continue to decrease from several days before until one day after the disturbed day and the decrement of dispersions is not less than about 25%. Variations of the daily sum of K-index during both periods when the occurrence rate of whistlers is increased and decreased have been also investigated. The results obtained are also consistent with the first case. Receptions of hiss at Wakkanai during the period of intense solar eruptions which occurred in Nov. 1960 are briefly reported. (auth)

12895 AMPLIFICATION OF THE VLF ELECTROMAGNETIC WAVE BY A PROTON BEAM THROUGH THE EXOSPHERE. Ken-ichi Maeda and Iwane Kimura (Kyoto Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 92-5(Jan. 1962).

The possibility is examined of amplification of a VLF electromagnetic wave by means of a charged particle beam running through the exosphere, with a view to applying it to the originating mechanism of the VLF emissions. A traveling wave tube (TWT) like mechanism was one of the hypotheses explaining the VLF emissions. However, it seems doubtful that such a mechanism can really occur in the exosphere. In place of a TWT mechanism, it is found that an interaction of the VLF wave with a proton cyclotron wave of a beam works as an amplifying mechanism, although the gain of amplification is not so great, 20 db per 1000 km coupling. Therefore a powerful noise seed must be needed, in order to interpret the VLF emissions. This noise would come from the vicinity of the ground through the ionosphere by the whistler mode. (auth)

12896 WHISTLERS AND VLF EMISSIONS IN CONNECTION WITH THE EARTH STORMS. Ken-ichi Maeda (Kyoto Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 95-103(Jan. 1962).

Fundamental features of whistlers and VLF emissions including hiss, dawn chorus, and others are briefly reviewed and important characteristics in disturbed states are studied. The related theories to interpret the phenomena are surveyed, and discussions are given on some important characteristics of the phenomena. Some suggestions on data reduction and on possible experimental studies by means of satellite are also proposed. (auth)

12897 BALLOON X-RAYS AND THE RADIATION BELTS. J. R. Winckler (Univ. of Minnesota, Minneapolis). J. Phys. Soc. Japan, 17: Suppl. A-II, 104-14(Jan. 1962).

X-ray measurements, made with balloons and rockets, associated with the dumping of electrons from the magnetic field are discussed. It is shown that in the normal auroral zone the x-ray bursts occur throughout the 24-hour period, have peak intensities corresponding to electron fluxes of 10^6 to $10^7/cm^2 \cdot$ sec, and have peak integrated

fluxes over a 24-hour period of $10^{10}/cm^2$. In the auroral zone the x-ray bursts arising from 30 kv or higher electrons are not correlated with visible aurorae. Direct rocket measurements of bright aurorae in the auroral zone confirm this by showing the absence of appreciable electron fluxes above 20 kv. At lower latitudes, however, the x rays are well-correlated with visible aurorae, have peak burst intensities of 10^9 electrons/cm^2 · sec greater than 30 kv, and are also strongly correlated with negative bays in the local magnetic field. The Van Allen outer radiation belt electrons provide a suitable reservoir for explaining many characteristics of the x-rays because of the latitude distribution and energy of the trapped radiation. Acceleration, deceleration, and redistribution processes are suggested which may result in the precipitation of these electrons to form the x rays. (auth)

12898 THE COSMIC RAY NEUTRON DENSITY AT HIGH ALTITUDES. R. C. Haymes, W. P. Reidy, and S. A. Korff (New York Univ., New York). J. Phys. Soc. Japan, 17: Suppl. A-II, 115-17(Jan. 1962).

A series of measurements of cosmic-ray neutrons at high altitudes carried out over the past several years is discussed. The work, which is of interest in connection with the problems of isotope production, neutron albedo, and the energy balance, was conducted using balloons and sounding rockets. (W.D.M.)

12899 INJECTION OF TRAPPED PROTONS FROM SOLAR FLARE PARTICLES. A. M. Lenchek and S. F. Singer (Univ. of Maryland, College Park). J. Phys. Soc. Japan, 17: Suppl. A-II, 123-7(Jan. 1962).

Protons coming from the sun cannot be trapped directly. An injection mechanism is calculated as follows. Solar protons arriving at the polar cap produce albedo neutrons, some of which decay within the geomagnetic field at lower latitudes. In the decay, protons are released, most of which are dumped into the atmosphere at lower latitudes but some of which are trapped. The injection coefficients of these two cases are calculated as well as absolute intensities for typical solar events. The newly trapped protons show some peculiar properties when compared to the protons injected by the galactic cosmic rays. They exhibit a peculiar angle distribution and therefore spatial distribution with a depression of omnidirectional intensity in the equatorial plane. Their decay proceeds with the development of a peak in the energy spectrum which moves upward as time progresses. (auth)

12900 OBSERVATION OF THE RADIATION ANOMALIES AT THE ALTITUDES OF 200-300 KM. V. L. Ginzburg, L. V. Kurnosova, V. I. Logachev, L. A. Razorenov, and M. I. Fradkin (Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-II, 128-31(Jan. 1962).

Radiation measurements from Sputnik V (310 to 330 km) and Sputnik VI (190 to 260 km) in the latitude range −65° to 65° are shown. The South Atlantic and South anomalies are discussed, and counting rate changes are shown. (W.D.M.)

12901 CORRELATION BETWEEN OUTER RADIATION BELT AND SOLAR-GEOPHYSICAL PHENOMENA. Sekiko Yoshida (Nagoya Univ., Japan), Nobuo Matuura, and Takesi Nagata. J. Phys. Soc. Japan, 17: Suppl. A-II, 132-8(Jan. 1962).

The study of time variations of the outer radiation belt may be highly important in relation to its origin. Since the discovery of the radiation belts, it has been well known that flux intensity of the outer radiation belt varies appreciably in association with magnetic storms. An attempt is made to obtain an understanding of the mechanism of flux variations. (W.D.M.)

12902 STÖRMER'S INNER ALLOWED REGIONS AND THE RADIATION BELTS. Ruth Gall (Universidad Nacional Autonoma, Villa Obregon, Mexico and Instituto Nacional de la Investigacion, Mexico). J. Phys. Soc. Japan, 17: Suppl. A-II, 139-44(Jan. 1962).

The study of the inner allowed regions, deduced from Störmer's theory, was undertaken to shed some light on the properties of the trapping mechanism that operates within the radiation belts. It is generally accepted that the radiation belt particles follow trapped orbits which lie entirely within the inner allowed regions. These zones are characterized by Störmer's constant of motion, gamma. It is seen that in the radiation belts this constant provides a criterion for the validity domain of the adiabatic condition, as far as the mirror latitude is concerned. (auth)

12903 MECHANISM OF THE MIRROR POINT LOSS. S. Fukui, S. Hayakawa, H. Nishimura, and H. Obayashi (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 144-7(Jan. 1962).

In cosmic-ray physics various problems are concerned with the behavior of charged particles in a magnetic field, i.e., formation and stability of the radiation belts, the observed anisotropy of the heavy primaries, etc. A simple model experiment was performed in order to get characteristic information about the loss mechanism of electrons from a magnetic bottle. Some preliminary results are given. (W.D.M.)

12904 SOURCE OF ELECTRONS IN THE VAN ALLEN BELTS. P. J. Kellogg (Univ. of Minnesota, Minneapolis). J. Phys. Soc. Japan, 17: Suppl. A-II, 148-50(Jan. 1962).

At the present time, three years after the discovery of the Van Allen belts, the source of the trapped electrons is still not understood. It has been shown that these electrons cannot be due to the beta decay of albedo neutrons as this source is too weak. Comparison of measurements made by the U. S. space probe Pioneer V and the satellite Explorer VII shows that the electrons do not come from the sun, at least with the energy that they have after trapping. It appears therefore that the electrons of the Van Allen belts are accelerated in the trapping region, with the acceleration energy somehow supplied by the sun. Recently it has been shown that during the main phase of a magnetic storm, a ring current develops in the region around 10 earth radii. Since the earth's equatorial field is reduced, this ring must represent the arrival of new energy in the trapping region. Comparison of cosmic ray cutoff observations and geomagnetic measurements shows that after its formation, the ring moves inward, without much loss of total energy. This inward motion can be understood if the particle energy in the ring is shuffled among particles in a way that preserves $W_\perp/B$; i.e., by a process whose time constant is longer than the cyclotron period. Those particles which gain energy then move inward, and therefore so does the effective position of the ring. This picture also agrees with observations of the outer Van Allen zone during and after magnetic storms. Conjectures can be made about the mechanism which causes the shuffling of the particle energy. It seems possible that a known plasma instability associated with a "pancake" velocity distribution is responsible and this throws light on the original mechanism for ring current formation. (auth)

12905 PARTICLE DIFFUSION IN THE RADIATION BELTS. N. Herlofson (Royal Inst. of Tech., Stockholm). J. Phys. Soc. Japan, 17: Suppl. A-II, 151-3(Jan. 1962).

It is commonly accepted that the geomagnetic field holds the radiation belts together, with each particle spiralling smoothly along the field lines. The main loss

mechanism is held to be Coulomb scattering by background particles in the exosphere. The scattering effect of small scale magnetic deviations in random directions, superimposed on the geomagnetic ffeld, is considered. Properties of any isotropic scattering process are noted and isotropic magnetic scattering is analyzed. (W.D.M.)

12906 DYNAMICS OF THE OUTER RADIATION BELT. J. A. Simpson, C. Y. Fan, and P. Meyer (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-II, 154-61(Jan. 1962).

From an analysis of electron measurements in the Explorer VI satellite (August 7–October 6, 1959) four time-dependent parameters have been investigated which characterize the outer electron belt. They are: (1) the equatorial electron intensity I_0, (2) the equatorial range from the earth R_0 of the peak intensity, (3) the electron density distribution along a line of force through the intensity peak, and (4) a measure of the change in electron spectrum with time. These parameters along with measurements of magnetic field intensity make it possible to study the origin of the changes in electron intensity and distribution which are known to occur in the outer belt. Several magnetic storms occurred during the observation on Explorer VI. The behavior of the outer electron belt during the geomagnetic storms of August 16 and August 20 was analyzed in detail. A summary of the changes in the four parameters is given. The electron fluxes, high energy proton fluxes, and possible electron spectra are investigated. Two distinct peaks of electron intensity are identified to persist in the outer belt for about two months, and it is shown that these peak distributions undergo radial motion during geomagnetic disturbances. (auth)

12907 INVESTIGATIONS OF RADIATION DURING FLIGHTS OF SATELLITES, SPACE VEHICLES AND ROCKETS. S. N. Vernov, E. V. Gorchakov, Yu. I. Logachev, V. E. Nesterov, N. F. Pisarenko, I. A. Savenko, A. E. Chudakov, and P. I. Shavrin (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-II, 162-87 (Jan. 1962).

Data are given on the outer belt at 320 km, detection of the inner belt at 320 km in the region of the South Atlantic magnetic anomaly, the radiation belts at 180-250 km, charged particle intensities after chromospheric burst of July 7, 1958, study of the outer belt during flights of space rockets, cosmic-ray equator, distribution of cosmic rays at 300 km, and the height dependence of the particle intensity in the outer belt. (W.D.M.)

12908 NATURE AND ORIGIN OF RADIATION BELTS. S. F. Singer (Univ. of Maryland, College Park). J. Phys. Soc. Japan, 17: Suppl. A-II, 187-93(Jan. 1962).

Recent developments in the neutron albedo theory are reported, and the results are compared with observational data. Protons. The calculated energy spectrum agrees extremely well with the observed spectra, provided nuclear interactions and an anisotropic emission of albedo neutrons are taken into account. The spatial distribution is calculated on the basis of the determination of geometric injection coefficients. The lifetime is assumed to be controlled by exospheric densities close to the earth and determined by the breakdown of the adiabatic invariance of magnetic moment at larger distances. This leads to a maximum intensity at about $1\frac{1}{2}$ earth radii and a virtual disappearance of protons at about 2 earth radii. The absolute intensities of trapped protons calculated from neutron albedo theory and the most reasonable exospheric models are in very good agreement with observations in nuclear emulsions. Electrons. From neutron albedo, properties of the resulting trapped electrons are calculated. The lifetime is a particularly challenging problem. It is concluded that only a fraction of the observed trapped electrons can be of neutron albedo origin, possibly most of the high energy electrons, i.e., above 500 kev. The remainder, and particularly the large bulk of low energy electrons are locally accelerated, with the energy ultimately derived from the sun. (auth)

12909 SOME FEATURES OF THE TYPE IV RADIO-BURSTS. E. I. Mogilevskii (Mogilevsky) and S. T. Akiniyan (Akinijan). J. Phys. Soc. Japan, 17: Suppl. A-II, 195-8 (Jan. 1962).

Some features of type IV radiobursts, interesting for the solution of the problem on generation of geoeffective corpuscular streams on the sun, are briefly reported. Observations of solar radio emission by radiotelescopes, observations of chromospheric flares, IGY data of radioburst observations, and radiospectral data from Fort Davis were used in the study. (W.D.M.)

12910 TYPE IV (CONTINUUM) RADIO BURSTS FROM THE SUN. A. R. Thompson (Harvard Radio Astronomy Station, Fort Davis, Tex.). J. Phys. Soc. Japan, 17: Suppl. A-II, 198-203(Jan. 1962).

The characteristics of type IV bursts are described from sweep frequency observations in the ranges 25-580 Mc/s and 2100-3900 Mc/s. The bursts typically commence a few minutes after the start of a flare of high importance, cover a wide frequency range, and may last for several hours. The association of the bursts with type II (slow-drift) bursts and type III (fast-drift) bursts is also discussed. Approximately 40% of type IV bursts are followed by polar cap absorption and 75% by magnetic storms. (auth)

12911 STRUCTURE OF THE TYPE IV RADIO BURST AND ITS RELATION WITH SOLAR COSMIC RAYS. A. Boischot and M. Pick (Meudon Observatory, France). J. Phys. Soc. Japan, 17: Suppl. A-II, 203-6(Jan. 1962).

The type IV burst is actually made of at least two distinct parts. The first one is seen on centimetric, decimetric, and sometimes metric wavelengths, and may be explained by a synchrotron mechanism. The first part is followed by the second one, more intense on metric wavelengths, and which lasts generally a few hours. In some cases, the emission is received one day or more, and these long durative events have been named continuum storm. The source of the emission lies low in the corona and its diameter is relatively small. The radiation is strongly circularly polarized in the ordinary mode, like the noise storms. A plasma Cherenkov mechanism is proposed to explain this second part. High energy electrons would diffuse in coronal streamer, exciting longitudinal plasma waves, which can transfer a part of their energy upon transverse electromagnetic waves in some regions close to the critical height. (auth)

12912 YEARLY VARIATION IN ACTIVITIES OF OUTBURSTS AT MICROWAVES AND FLARES DURING A SOLAR CYCLE WITH SPECIAL REFERENCE TO UNUSUAL COSMIC-RAY INCREASES. Tatsuo Takakura and Minoru Ono (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 207-10(Jan. 1962).

An interesting characteristic of unusual cosmic-ray increases, that they occur only in ascending and descending phases of solar cycles avoiding the sunspot maxima, is investigated as to whether it is solar effect or not. It is shown that most intense outbursts of microwaves, which seem to be a good measure for the acceleration of particles in the solar atmosphere, show the same tendency as the cosmic-ray increases have, in spite of the fact that importance 3^+ flares occur most frequently in sunspot maxi-

mum. This tendency might simply be due to some conditions unfavorable to accelerate particles at the sunspot maximum. However, if it is assumed that an eruption accompanying both a 3^+ flare and an acceleration of appreciable number of particles is more intense than an eruption accompanying only a 3^+ flare, it may be inferred that the most intense eruptions tend to occur away from the sunspot maximum actually avoiding the maximum phase. Unusual cosmic ray increases occurring away from the sunspot maximum may be a solar effect rather than an interplanetary modulation effect. (auth)

12913 SOME COMMENTS ON TYPE IV BURSTS. Haruo Tanaka and Takakiyo Kakinuma (Nagoya Univ., Toyokawa, Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 211-14(Jan. 1962).

It has become clear that a large continuum burst is composed of 4 distinctive types, CM_1, CM_2, DM, and IV, which originate from different altitudes over the photosphere. The observational characters of each type are given. CM_1 is the main phase of a centimeter-wave burst originating from about 0.02-0.05 R_S in height. DM burst is polarized in the ordinary sense, which is the cause of reversal of polarization with frequency. Its center frequency lies between about 1000 and 200 Mc/s, and is often misunderstood as the original Type IV burst. The movement of magnetic field during a burst is suggested. CM_2 may be considered as an enhancement of the upper part of the source of S-component caused by this movement of the field. (auth)

12914 THE NATURE OF TYPE IV SOLAR RADIO BURSTS. M. R. Kundu (Univ. of Michigan, Ann Arbor). J. Phys. Soc. Japan, 17: Suppl. A-II, 215-19(Jan. 1962).

From an analysis of spectral observations at Michigan, Fort Davis, and Sydney in the 25-600 Mc/s range, combined with simultaneous interferometric and single frequency observations in the range of frequencies 1000-9400 Mc/s and on 87 and 340 Mc/s, it is found that type IV emission in the range of frequencies 25-580 Mc/s occurs in two distinct phases: (a) the first phase, usually observed at frequencies higher than about 250 Mc/s, appears to be an extension of the associated centimeter-wave burst which is also a broadband continuum emission. This emission occurs earlier than the associated type II burst and can even occur independent of any type II burst. The source of this emission is situated low in the chromosphere, has no significant movement and has a small angular size, usually less than 4′. The observed properties of this phase of continuum emission are consistent with the suggestion that it is caused low in the chromosphere by synchrotron radiation of electrons generated during the flare. When this phase occurs alone, the geomagnetic activity index increases slightly, 2-5 days after the type IV burst. (b) the second phase, usually observed at frequencies lower than about 250 Mc/s, is closely associated with a type II burst preceding it. The source of this continuum emission is situated high in the corona and moves with velocities of more than 1000 km/s. It has a large angular size, usually 10′ or larger. This second phase of type IV emission was previously explained as due to synchrotron radiation of electrons higher in the corona, when a cloud of gas with a shock front (which excites the type II burst) moving at high velocities carries a frozen-in magnetic field to the appropriate heights in the corona. There is a great increase in geomagnetic activity index, 1-2 days after the second phase of type IV burst. (auth)

12915 HEIGHT AND MOTION OF THE SOLAR RADIO BURSTS AT 200 Mc/s. M. Morimoto (Tokyo Astronomical Observatory) and K. Kai. J. Phys. Soc. Japan, 17: Suppl. A-II, 220-3(Jan. 1962).

The results of positional observations made with an interferometer at 200 Mc/s at Tokyo Astronomical Observatory are discussed. The height of a radio source is about 0.2-0.3 R_S above the photosphere for type I, type III, and type IV bursts, and it increases with a distance from the center. This is far above the plasma level expected from the normal coronal model. It is suggested that some kind of condensation exists above the active region of the sun. The frequency of type I bursts concentrates to the disk center, while that of type III bursts rather increases near the limb. The difference is briefly discussed. The scattering range of positions in a group of type III bursts is roughly independent of the position of the burst on the disk, and is about equal to the scale height in the coronal condensation, mentioned above. The source of type IV burst usually does not show an ejected motion, in contrast with the results at the lower frequencies. The source of type II burst often shows an ejected motion, it seems inconsistent with the plasma hypothesis. (auth)

12916 THE SIZES OF THE SOURCES OF SOLAR RADIO BURSTS AT 40 AND 60 Mc/s. A. A. Weiss and K. V. Sheridan (Commonwealth Scientific and Industrial Research Organization, Sydney). J. Phys. Soc. Japan, 17: Suppl. A-II, 223-7(Jan. 1962).

A swept-phase interferometer has been used in conjunction with the radio spectrograph and the swept-frequency interferometer to study the angular sizes of the sources of the bursts of radio emission from the sun. Measurements were made at either 40 or 60 Mc/s and with aerial spacings of 1 km or $\frac{1}{4}$ km. A preliminary discussion on the data is presented. (W.D.M.)

12917 A MODEL OF THE CORONAL CONDENSATION. Eijiro Hiei (Tokyo Astronomical Observatory). J. Phys. Soc. Japan, 17: Suppl. A-II, 227-31(Jan. 1962).

The electron density and the electron temperature of the coronal condensation were determined by the optical observation at the total solar eclipse of October 12, 1958, in the South Pacific. The distribution of the electron density was derived from the direct photographs of the corona. At 100,000 km above the photosphere the electron density was ten times higher in the condensation than in the normal corona. The temperature is uncertain owing to the ambiguity in collisional cross-section. From the equivalent widths of three emission lines, i.e., λλ 3987 Fe XI, 4086 Ca XIII, and 4231 Ni XII appearing on the flash spectrograms, the electron temperature was estimated to be slightly higher in the condensation than in the normal corona. (auth)

12918 STRUCTURE OF THE FLARE. Z. Suemoto, E. Hiei, and T. Hirayama (Tokyo Astronomical Observatory). J. Phys. Soc. Japan, 17: Suppl. A-II, 231-3(Jan. 1962).

The line widths of Balmer series lines from H_α to H_{14} were measured on a number of spectrograms of disk flares and limb flares of medium importance taken by a wide range spectrograph with the dispersion of 3A/mm. From these widths the values of the electron density and the total number of hydrogen atoms along the line of sight in the second quantum state are derived. On the basis of uniform model of the flare, these two values can only be made compatible when the very small geometrical thickness of the order of 10 km is attributed to the whole extension of the disk flare and the limb flare. It is suggested, therefore, that the flare is composed of unresolvably fine, presumably

threadlike, condensations distributed over the whole extension. Further since the limb flares show essentially the same structure as the disk flares, one is inclined to believe that the origin of the flare must lie somewhere in the corona or in the higher chromosphere. Moreover it is suspected that all the disk flares might be limb flares seen projected on the disk. (auth)

12919 ON THE EXCITERS OF TYPE II AND III SOLAR RADIO BURSTS. Yutaka Uchida (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 234-7(Jan. 1962).

The exciters of transient solar radio emissions, the type II and type III bursts, are discussed mainly from the view point of velocity with which their sources move in the solar atmospheres. The propagation velocities of several possible types of disturbances in the physical condition above a typical sunspot are considered in order to account for the observed velocities and their variation with height of each type of bursts, and it is concluded that the exciters of type II bursts are the hydromagnetic shock front, while those of type III bursts are the free streaming group of high velocity charged particles. (auth)

12920 OPTICAL EVIDENCE FOR CORPUSCULAR RADIATION OF THE SUN. M. Waldmeier (Eidgenossische Sternwarte, Zurich). J. Phys. Soc. Japan, 17: Suppl. A-II, 238-43(Jan. 1962).

Much work has been done on a search for optical or radioastronomical properties of flares that will permit forecasters to distinguish storm-producing from non-disturbing flares. The characteristics of the three types of solar corpuscular radiation and their terrestrial effects are given. Various observations are cited which give strong support to the idea that the long, stable rays of the corona represent corpuscular streams. (W.D.M.)

12921 SOLAR RADIO OUTBURSTS AND ACCELERATION OF ELECTRONS. Tatsuo Takakura (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 243-9(Jan. 1962).

Wide-band spectra of intense long-duration outbursts are studied. In a course of such an outburst there occur three distinctive components of outburst. One is long-duration outburst of cm-waves and the other is believed to be original type IV burst of m-waves. These groups occur with a clear gap in the frequency range or are mixed in some frequency ranges by accompanying another group of dm-waves. In order to account for the above characteristics, acceleration of electrons due to hydromagnetic waves is discussed. In order that the accelerations proceed to relativistic energies, redistribution of the velocity of accelerated electrons must be made. This redistribution may be made by Coulomb collisions with thermal electrons before their energies are lost by the collisions. The accelerated electrons tend to accumulate in the places where the magnetic field is greater to radiate synchrotron radiations. At intense eruption, a few magnetic bulges would be separate radio sources for m-IV, dm-IV and cm-IV outbursts. It is also shown that hard x-ray bursts and microwave bursts with short durations are consistently explained by the same electrons accelerated at moderate eruptions. (auth)

12922 THE RADIO EMISSION FROM SOLAR FLARES. J. P. Wild (Commonwealth Scientific and Industrial Research Organization, Sydney). J. Phys. Soc. Japan, 17: Suppl. A-II, 249-58(Jan. 1962).

The radio emission from solar flares is of special interest in the study of geomagnetic storms and solar cosmic rays because it gives a direct indication of the passage of ionized streams of gas through the Sun's atmosphere. The nature of these emissions is reviewed in a general way. (auth)

12923 SOME RELATIONS BETWEEN CENTIMETER-WAVE RADIO BURSTS AND SOLAR COSMIC RAYS AND X-RAYS. M. R. Kundu (Univ. of Michigan, Ann Arbor). J. Phys. Soc. Japan, 17: Suppl. A-II, 259-64(Jan. 1962).

Dynamic spectrum observations have shown that cm-λ outbursts exhibit a broadband continuum radiation. The cm-λ outbursts associated with ground level cosmic ray increases have usually a long duration and a strong intensity (peak flux $> 2000 \times 10^{-22}$ wm^{-2}[c/s]$^{-1}$) over a wide range of wavelengths between 3 and 30 cm. The polar cap absorption (PCA) events are all associated with broadband cm-λ outbursts having a duration greater than 10 minutes. The delay of PCA events with respect to cm-λ outbursts is statistically dependent both on the intensity of cm-λ outbursts as well as the position on the disc of the associated flares. Intense broadband cm-λ outbursts having a duration longer than 10 minutes and a peak intensity greater than 500×10^{-22} wm^{-2} (c/s)$^{-1}$ over the entire range of wavelengths 3 to 30 cm are followed by PCA events in 80% cases. The cm-λ bursts are very closely associated with the production of flare x-rays as observed by rocket and balloons. The association of meter-wave type III bursts with flare x-rays is very weak. (auth)

12924 CHARACTERISTICS OF SOLAR-FLARE COSMIC RAYS DURING IGY. J. C. Anderson (Univ. of Nebraska, Lincoln), R. L. Chasson, and Kaichi Maeda. J. Phys. Soc. Japan, 17: Suppl. A-II, 264-8(Jan. 1962).

The effect of solar flares of class 2+ and greater on the intensity of the low-energy nucleonic component of cosmic rays at different locations on the earth has been studied by the Chree method of superposed epochs. Data analyzed were from Chicago, Climax, Mexico City, Lincoln, Sacramento Peak, and Wellington for the period July 1957 to December 1958. The sun was divided into regions and possible differences between the effect of eastern, central, and western groups of flares have been studied. It seems that no coherent result is evident when comparing several stations during the same year; furthermore, no self-consistent results between 1957 and 1958 for individual stations were found. (auth)

12925 COSMIC RAY INCREASES ASSOCIATED WITH SOLAR FLARES. B. G. Wilson and C. P. Nehra (Univ. of Alberta, Calgary). J. Phys. Soc. Japan, 17: Suppl. A-II, 269-72(Jan. 1962).

Neutron intensity changes associated with optical flares on the sun have been studied using the data recorded on Sulphur Mountain during 1959 and 1960. A small positive correlation exists in the measurements which appears greater for flares associated with ionospheric disturbances than otherwise. (auth)

12926 ON A MAXIMUM OF COSMIC-RAY INTENSITY PRIOR TO A PREBAISSE-EFFECT. L. D. de Feiter (Netherlands Postal and Telecommunications Services) and J. P. Legrand. J. Phys. Soc. Japan, 17: Suppl. A-II, 272-4(Jan. 1962).

From an analysis of the neutron monitor data of the Nov. 1960 events it was found that the cosmic ray intensity increased by about 3% on Nov. 5. At that date the center of activity in which the series of three cosmic ray flares was produced, turned onto the visible hemisphere of the sun. The proposition that a connection exists between cosmic ray intensity and the position of some important activity centers on the solar disk is considered. (W.D.M.)

12927 SOLAR ACTIVE REGIONS AND SOLAR COSMIC RAYS. John C. Noyes (Boeing Scientific Research Labs., Seattle). J. Phys. Soc. Japan, 17: Suppl. A-II, 275-81(Jan. 1962).

A study has been made of solar active regions in which occurred flares which produced solar cosmic rays—primarily protons in the energy range of a few Mev to a few Bev—during the period July 1957-December 1960. Of 40 solar cosmic ray events that occurred during this period, 35 could be attributed to 26 active regions. The regions producing the majority of the 35 events were characterized (not necessarily simultaneously) by $\beta\gamma$ or γ sunspot magnetic complexity, sunspot areas $>200 \times 10^{-6}$ of the solar hemisphere and five or more flares of importance ≥ 2. Over two-thirds of the flares producing the cosmic rays occurred (a) in the northern solar hemisphere, (b) west of the central meridian, and (c) on first or second rotation of the parent active region. However, some significantly strong events did not fall in with the majority. The strength of polar cap absorption, measured by riometers in db, was correlated to some extent with the strength of related geomagnetic storm, although anomalies existed. On the average, active regions producing solar protons form a part of a larger population of the most active solar regions. However, aside from the average trend noted, none of the gross characteristics of the proton-producing regions distinguished them from other regions. It is suggested that other features of a finer nature—magnetic and thermodynamic details—make the difference between cosmic ray flares and non-cosmic-ray flares. (auth)

12928 INTENSITY OF SOLAR PROTON EMISSIONS. E. L. Chupp (Boeing Co., Seattle) and R. W. Williams. J. Phys. Soc. Japan, 17: Suppl. A-II, 281-5(Jan. 1962).

The intensity of proton emissions associated with solar flares has been studied over the period of maximum activity for solar cycle 19. During this period, from 23 February 1956 to 3 September 1960, there were 43 events in which there was experimental evidence for solar proton emission. Using the published data for these events we have estimated the time integrated free space proton flux for several of the events. For those events observed only by riometers the integrated flux was determined by taking the proton intensity to depend quadratically on the riometer absorption and assuming that the time history for all events is similar. A summary is given of the estimated integrated flux (size) for 36 of the events. These data are then used to determine the integral size-frequency distribution, giving the average rate of occurrence, during solar maximum, of events larger than any specified size. The relatively flat size spectrum and the corresponding intensity spectrum have a shape approximating an inverse power law. It is suggested that this observation may be interpreted as defining a general property that any theory must possess which attempts to explain the acceleration of energetic protons during flares. The size distribution may also be used for estimating the hazard for a manned space system. (auth)

12929 COSMIC RAY EFFECTS ASSOCIATED WITH POLAR CAP ABSORPTION EVENTS. V. A. Sarabhai and G. L. Pai (Physical Research Lab., Ahmedabad, India). J. Phys. Soc. Japan, 17: Suppl. A-II, 286-9(Jan. 1962).

Cosmic-ray effects associated with polar cap absorption during the period May 1957 to July 1959 were studied. Cosmic-ray intensity data extending continuously from −5 to +10 days of each event are available for 21 events at trivandrum, Huancayo, and Climax. (W.D.M.)

12930 A SYNOPSIS OF RIOMETER OBSERVATIONS ON THE POLAR CAP EVENTS OF NOVEMBER 1960. T. R. Hartz and E. L. Vogan (Defence Research Telecommunications Establishment, Ottawa). J. Phys. Soc. Japan, 17: Suppl. A-II, 289-93(Jan. 1962).

During November 1960, a number of outstanding disturbances of the earth's upper atmosphere occurred which have been attributed to the arrival of energetic, charged particles from major flares on the sun. These disturbances have been studied with the aid of a number of riometers at stations located along a north-south line across the auroral zone—from Resolute Bay to Ottawa, Canada. Ionospheric absorption data are presented for the period 12-17 November with particular emphasis being placed on the polar cap absorption events of November 12 and November 15. The ratio of absorption at 30 Mc/s to absorption at 60 Mc/s has been evaluated for certain periods. These data are discussed and interpreted in terms of height of the absorbing region. (auth)

12931 THE SOLAR COSMIC-RAY INCREASE OF NOVEMBER 20, 1960. H. Carmichael and J. F. Steljes (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys. Soc. Japan, 17: Suppl. A-II, 293-6(Jan. 1962).

Visual, radio, and neutron monitor observations indicate that a major solar flare situated some 20° behind the W limb of the sun occurred on Nov. 20, 1960, and produced high energy particles which reached the earth. A magnetic storm and a Forbush decrease may have been caused by this flare. The data from 30 neutron monitors and ten meson monitors for the whole month of Nov. 1960 are shown. (auth)

12932 GEOMAGNETIC STORM EFFECT ON THE SOLAR COSMIC-RAYS IN NOVEMBER 1960 AND THEIR PROPAGATION PROCESS IN THE INTERPLANETARY SPACE. Masahiro Kodama (Inst. of Physical and Chemical Research, Tokyo) and Masatoshi Kitamura. J. Phys. Soc. Japan, 17: Suppl. A-II, 298-302(Jan. 1962).

The cosmic-ray unusual increases of November 12 and 15, 1960, are investigated by using the cosmic ray neutron data from the stations distributed over the world, especially in the Arctic and the Antarctic regions. The gradual rise of the 1st hump of November 12, 1960, is explained by both the geomagnetic modulation in the initial phase of the geomagnetic storm and the trapping of the solar cosmic ray particles by the solar magnetic cloud responsible for the geomagnetic storm. The 2nd hump on November 12 is due to the geomagnetic modulation effect in the main phase of the storm combined with the supply of low energy particles trapped by the cloud. The primary energy spectrum of the differential intensity for flare increases on November 12 is obtained as $KE^{-\gamma}$ with $\gamma = 6$. In case of the November 15 event, the difference of the onset time in different localities suggests that the first incidence of the solar cosmic ray particles came from the direction of geomagnetic latitude 5°−30°S and next, about one hour later, they came from the opposite direction of 5°−30°N. (auth)

12933 OBSERVATIONS AT COLLEGE, ALASKA, OF THE NOVEMBER, 1960 COSMIC RAY INCREASES. Serge A. Korff (New York Univ., New York). J. Phys. Soc. Japan, 17: Suppl. A-II, 303-6(Jan. 1962).

The cosmic ray intensity and its variations, in the time interval between November 9 and 23rd, 1960 is presented and discussed. The time-sequence of the fluctuations and the connections with other geophysical parameters such as aurorae, magnetic indices, and forward-scatter ionosphere observations is described. It is suggested that the high energy particles and the low energy plasma clouds are not necessarily always emitted in the same directions from the sun. (auth)

12934 INCREASE OF THE COSMIC-RAY NUCLEONIC INTENSITY IN NOVEMBER, 1960. J. A. Lockwood and M. A. Shea (Univ. of New Hampshire, Durham). J. Phys. Soc. Japan, 17: Suppl. A-II, 306-9(Jan. 1962).

Two large increases and at least two rapid Forbush decreases in the cosmic radiation at the earth were observed between Nov. 12 and 16, 1960. A report is presented on the intensities of the nucleonic component at Mt. Washington and Durham, N. H.; the rigidity spectra of the relativistic solar produced particles; preferred regions of impact at the earth for solar particles; and evidence for dispersion effects during the first flare event. (W.D.M.)

12935 THE PROPAGATION OF COSMIC RAYS THROUGH INTERPLANETARY SPACE ON MAY 4, 1960, AND DURING NOVEMBER 1960. K. G. McCracken (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. A-II, 310-14(Jan. 1962).

A brief summary of some recent studies of the solar flare effect is presented. The use of neutron monitor data to establish the manner in which the unidirectional flux of flare radiation depends upon direction is considered. The flare effect of May 4, 1960, is investigated. Maps of the cosmic ray flux are prepared for the Nov. 12 and 15 flare effects. (W.D.M.)

12936 SHORT-TERM INCREASES OF THE COSMIC-RAY NUCLEI INTENSITY ASSOCIATED WITH THE SOLAR ACTIVITY. L. V. Kurnosova, L. A. Razorenov, and M. I. Fradkin. J. Phys. Soc. Japan, 17: Suppl. A-II, 315-16 (Jan. 1962).

Counters on the second Soviet space probe (Lunik II, 1959) detected nuclei with the charge $Z \geq 2$, $Z \geq 5$, and $Z \geq 15$. The counting rate, obtained by averaging over the great time intervals, was practically constant after the probe had passed the outer radiation belt. Sometimes counting rates were observed during separate short time intervals considerably above the mean values. Four such events are listed. (W.D.M.)

12937 HEAVY NUCLEI IN SOLAR COSMIC RAYS. C. E. Fichtel (NASA, Goddard Space Flight Center, Greenbelt, Md.) and D. E. Guss. J. Phys. Soc. Japan, 17: Suppl. A-II, 321-5(Jan. 1962).

Rocket borne nuclear emulsions flown into solar cosmic ray events during 1960 from Fort Churchill were examined for the presence of particles with charges greater than two. Heavy nuclei ($Z \geq 3$) in excess of normal galactic cosmic ray background were detected in small numbers in the solar particle beam which began to arrive at the earth on 3 September 1960. Subsequently, they were found in much greater abundance in the larger events of 12 November 1960 and 15 November 1960. The properties of these heavy nuclei including their charge, energy, and flux are presented, and their significance is discussed. (auth)

12938 ROCKET OBSERVATIONS OF SOLAR PROTONS ON SEPTEMBER 3, 1960. L. R. Davis, C. E. Fichtel, D. E. Guss, and K. W. Ogilvie (NASA, Goddard Space Flight Center, Greenbelt, Md.). J. Phys. Soc. Japan, 17: Suppl. A-II, 326-8(Jan. 1962).

To obtain more detail of the character of solar particle beams in the range 2 to 250 Mev, sounding rockets were fired from Fort Churchill during solar flare events (June–Nov. 1960). The rockets carried a Geiger counter, scintillation detector, nuclear emulsions, and a magnetometer to provide rocket aspect as a function of time. Results are given for fourteen firings. (W.D.M.)

12939 SOLAR COSMIC RAY EVENT OF SEPTEMBER 3, 1960. P. D. Bhavsar (Univ. of Minnesota, Minneapolis). J. Phys. Soc. Japan, 17: Suppl. A-II, 329-34 (Jan. 1962).

Simultaneous balloon observations from two different latitudes were made during this solar cosmic ray event. A very remarkable feature of delayed propagation of solar cosmic rays through interplanetary space was studied. This delay was caused by the passage of solar cosmic rays through magnetic plasma clouds from previous flares. The delay was energy-dependent and could be easily seen from the time variations of the solar proton energy spectrum and intensity variations at two locations. The spectrum became steep, as the time passed, because of the late arrival of the low energy particles. Most of the time during the event, the intensity of solar cosmic rays at Minneapolis was lower than that at Churchill because of the higher geomagnetic cutoff at Minneapolis. This intensity became comparable at both the stations during the main phase of the magnetic storms, indicating that the geomagnetic cutoff at Minneapolis is removed during the main phase. (auth)

12940 A SURVEY OF POLAR CAP ABSORPTION EVENTS (SOLAR PROTON EVENTS) IN THE PERIOD 1952 THROUGH 1960. D. K. Bailey (National Bureau of Standards, Boulder, Colo.) and J. M. Harrington. J. Phys. Soc. Japan, 17: Suppl. A-II, 334-6(Jan. 1962).

From a detailed survey of signal-strength recordings from several high-latitude VHF ionospheric scatter paths it has been possible to detect and classify some 44 PCA's in the uninterrupted period from 1952 through 1960. It has also been possible to estimate the onset time and duration of each event. Some eight of these events have been accompanied by ground level increases in cosmic ray intensity and are thus describable as solar cosmic ray events. Most of the 44 events have been followed by significant magnetic storms some 15 to 30 hours after the onset of the ionospheric absorption over the polar cap. Of these, seven have exhibited the phenomenon of breakdown of Störmer cutoffs shortly after the onset of the magnetic storm, by the admission to lower magnetic latitudes, typically 60°N of solar protons of normally excluded energies. Strong solar cycle dependence in the occurrence of PCA's is found. Furthermore it is suggested that particle storage, apparently always present during times of high solar activity, is not well developed in sunspot minimum years, with the result that the few PCA's then are of relatively shot duration and localized in the polar cap. (auth)

12941 SOLAR PROTONS IN NOVEMBER 1960. E. P. Ney and W. Stein (Univ. of Minnesota, Minneapolis). J. Phys. Soc. Japan, 17: Suppl. A-II, 345-53(Jan. 1962).

During the Nov. 12 and 15, 1960, solar flare events, the Univ. of Minn. group flew 16 balloons in a five-day period in order to get relatively short emulsion exposures at various phases of the two events. In addition to data on the balloon flights, a brief review of other high altitude experiments on these events by various groups in the U. S. is given. (W.D.M.)

12942 GEOMAGNETIC AND INTERPLANETARY EFFECTS ON SOLAR COSMIC RAYS. J. R. Winckler (Univ. of Minnesota, Minneapolis). J. Phys. Soc. Japan, 17: Suppl. A-II, 353-60(Jan. 1962).

The energy spectra and the time variations for many of the larger solar cosmic ray events from 1958 to the present have been directly measured with balloons, satellites, and space probes. The direct measurements cover the range 10 to 300 Mev and show spectra to be characteristically steep compared with galactic protons. Small differences in the spectral shape and intensity determine whether the

solar cosmic rays will be detected at sea level or only at high altitude. Spectra measured on the earth reflect energy sensitive propagation as well as the characteristics of the source. Large differences exist in the time variations of the flare particles. Direct and rapid propagation from the sun is frequently accompanied by a slow decay. Delayed propagation even in the high energy region appears in many events. These delays seem associated with complex propagation routes from the flare region to the earth, frequently because of magnetic plasma clouds in interplanetary space. The lowering of Störmer cutoffs during strong geomagnetic storms is shown by many events studied and occurs coincident with the main phase of storms. Periodic intensity variations of solar cosmic rays have been observed at Minneapolis which may be caused by large-scale oscillations in the main field of the earth. (auth)

12943 COSMIC-RAY INTENSITY BURSTS IN THE STRATOSPHERE IN NOVEMBER 1960. A. N. Charakhchyan, V. F. Tulinov, and T. N. Charakhchyan (Lebedev Physical Inst., Academy of Sciences, USSR and Moscow State Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 360-5 (Jan. 1962).

Data are presented on the energy spectrum and absolute intensity of solar cosmic ray protons in cosmic ray flares recorded on Nov. 14, 15, and 21, 1960. About seventy measurements were made in the stratosphere at various latitudes. (W.D.M.)

12944 THE ENERGY SPECTRUM AND TIME DEPENDENCE OF THE INTENSITY OF SOLAR COSMIC RAY PROTONS IN FLARES. A. N. Charakhchyan, V. E. Tulinov, and T. N. Charakhchyan (Lebedev Inst. of Physics, Moscow and Moscow State Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 365-72(Jan. 1962).

Solar proton energy spectra in bursts in April 28, May 4, May 13, and Sept. 3, 1960, were measured. The effect of the softening of the proton energy spectrum in bursts during a Forbush decrease is discussed. The origin of short-path (7mm Al) particles appearing in the stratosphere only during a Forbush decrease is considered. Time dependencies of the intensity of primary protons during outbursts are in fair agreement with calculations based on proton diffusion theory in the interplanetary medium. (W.D.M.)

12945 FINE STRUCTURE OF FORBUSH DECREASES. Robert L. Chasson (Univ. of Nebraska, Lincoln). J. Phys. Soc. Japan, 17: Suppl. A-II, 373-8(Jan. 1962).

Chree analysis of neutron monitor data (15-minute epochs) showed specific recurrent behavior following time of onset of geomagnetic storms clearly accompanied by Forbush effects. Of specific interest is a recurrent oscillation of intensity observed for a narrow band of mid-latitude, sea-level stations during IGY. Parallel analysis of horizontal geomagnetic intensity at Koror shows no resemblance between detailed cosmic ray changes and the field variations. Arguments are presented to eliminate geocentric mechanisms controlling the effect, e.g., fluctuations of cut-off rigidity or variable modulation due to magnetized solar plasma being entrained in terrestrial radiation belts. Heliocentric particle-injection models are examined which have some satisfactory features to explain the oscillatory recurrence tendency: (1) clusters of trapped protons of solar origin moving in a distended solar magnetic field are considered with regard to their azimuthal drift around the sun and periodic encounters with the earth, and (2) "ringing" within the plasma behind the hydromagnetic shock front is considered with regard to resulting quasi-periodicity of intensity of trapped fields and the consequently different maximum rigidities of protons trapped within the travelling field regions, which successively encounter the earth. (auth)

12946 ANISOTROPY AND CHANGES OF ENERGY SPECTRUM DURING COSMIC RAY STORMS. V. A. Sarabhai (Physical Research Lab., Ahmedabad, India), G. L. Pai, and U. R. Rao. J. Phys. Soc. Japan, 17: Suppl. A-II, 379-83(Jan. 1962).

A study is reported of six major cosmic-ray storms using the superposed epoch method. The storms occurred on 9/28/57, 10/21/57, 11/25/57, 12/19/57, 3/25/58, and 8/16/58. Data from three equatorial stations, six stations at 50 ± 5°, and three polar stations were used. Results of the Chree analysis are shown for equatorial, high-latitude, and polar stations; separately for neutron monitors and meson telescopes. (W.D.M.)

12947 TIME VARIATION OF COSMIC-RAY INTENSITY FROM NORTH AND SOUTH DIRECTIONS AT LOW LATITUDES. V. Sarabhai and B. Gottlieb (Physical Research Lab., Ahmedabad, India). J. Phys. Soc. Japan, 17: Suppl. A-II, 384-6(Jan. 1962).

Following the results of Rao and Sarabhai of the time variations of cosmic-ray muon intensity for East and West directions at Ahmedabad (Long. 75°E, Geomag. lat. 14°N, sea level), an investigation was conducted, with the same apparatus, of variations of South and North intensities. Some preliminary results are presented of data obtained during 1959 and 1960 with telescopes of half-angle 20 × 45° inclined at 45° to the zenith. (auth)

12948 AN ATTEMPT OF ANALYZING COSMIC-RAY STORMS. Arne Eld Sandstroem (Inst. of Physics, Uppsala). J. Phys. Soc. Japan, 17: Suppl. A-II, 386-90(Jan. 1962).

It is shown that a beam model can explain the sequences of Forbush decreases and storm sudden commencements characteristic of cosmic-ray storms. It is also shown that there does not exist a regular 27-day period in the appearance of cosmic-ray storms associated with the return of active regions. (auth)

12949 SOLAR MAGNETIC CLOUD PRODUCING COSMIC-RAY STORM, MAGNETIC STORM, AND TYPE IV SOLAR RADIO OUTBURST. Yoshiko Kamiya (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 391-4 (Jan. 1962).

At the Moscow Meeting in 1959, good correlation was reported between the cosmic-ray storms and the solar flares associated with Type IV radio outbursts. In order to confirm this result, the study was continued for the data during the period 1959-1960 and the following results were obtained. (1) Cosmic-ray storms are closely associated with the radio outbursts of Type IV (continuum). The result indicates that the eruption followed by the radio outburst of Type IV is the cause of cosmic-ray storm. (2) The size of cosmic-ray and magnetic storm was compared with the heliographic longitude of the eruptions. Large magnetic storms occur after eruptions near the central meridian, while the size of cosmic-ray storm is independent of the heliographic longitude of the eruption. (3) From these results, a possible model of magnetized corpuscular cloud is presented which seems to be ejected from the sun with eruption followed by Type IV outburst. This model of magnetic cloud is a large total bulk with a core and appears to be able to consistently explain not only the facts above described but also the other earth storms. (auth)

12950 MECHANISM OF COSMIC RAY STORMS INFERRED FROM SOME STATISTICAL RESULTS. Kenji

Sinno (Radio Research Labs., Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 395-9(Jan. 1962).

Recently, evidence that cosmic-ray storms (Forbush decreases) usually correspond to solar flares accompanied by major solar radio outbursts on the VHF band, so called Type IV outbursts, has been reported. In the present investigation, the above evidence is confirmed by extended data of four years including IGY. Some statistical results on cosmic-ray storms concerned with heliographic position of flares and propagation time of storms are found. It is concluded that the larger cosmic-ray decreases are apt to be excited by the geomagnetic disturbances having shorter propagation time and flares at nearly 30° east heliographic longitude. These facts lead to the conception that an expanding corpuscular cloud having an intense magnetic field trails towards the east, so that cosmic-ray storms are the biggest from flares of the solar east hemisphere. Discussion is also presented on a physical picture of the cloud concerned with cosmic-ray storms. (auth)

12951 THE LATITUDE EFFECT OF COSMIC-RAY STORM. Hachiro Takahashi (Iwate Univ., Morioka, Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 400-2(Jan. 1962).

The statistical results concerning the latitude dependence of cosmic-ray storms associated with magnetic storms, analyzed by using the world-wide data of cosmic-ray neutrons obtained at mountain altitudes during the IGY, are presented and discussed. The results obtained without applying the corrections for the storm-time increases in cosmic-ray intensity found by Kondo et al. show that the latitude effect of cosmic-ray storms associated with magnetic storms is strongly dependent on the grade of the magnetic storm. Even after the corrections for the storm-time intensity increases have been applied, the results show that the latitude effect has a close relation with the magnetic storms though the feature somewhat differs from the former results. It is supposed that the latter results are not caused by geomagnetic effect (magnetic storm effect) but by solar modulation effect in interplanetary space. (auth)

12952 ON COSMIC-RAY INTENSITY INCREASE DURING GEOMAGNETIC STORM. Ichiro Kondo (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 402-7(Jan. 1962).

Studies were made on worldwide cosmic-ray intensity increases which were observed during geomagnetic storms. From statistical analysis of these events, the following results were obtained. This intensity increase was found to be a characteristic feature of cosmic-ray variation associated with severe geomagnetic storms. On the other hand, this intensity increase was not observed when the cosmic-ray storm was not associated with large geomagnetic storm. Assuming this intensity increase was caused by decrease of the magnetic cut off rigidity by depression of the geomagnetic field, the dependence of the increment on latitude was calculated. The observed increments at various stations were in good agreement with theoretical expectation. Thus it was concluded that this storm time increase is caused by the shift of the magnetic cut off rigidity. Observed neutron intensity variations during the cosmic-ray storms associated with large geomagnetic storms are strongly affected by this storm time increase. So in order to study the intensity variations during these storms, correction for this increase is necessary. (auth)

12953 COSMIC RAY MODULATION AND GEOMAGNETISM. A. Ehmert (Max-Planck-Inst. for Aeronomy, Lindau, Herz, Ger.). J. Phys. Soc. Japan, 17: Suppl. A-II, 416-18(Jan. 1962).

It is shown that the general ring current field contains at least three components of different nature: one caused by actual ring currents set up by storms; one by the interference of the solar plasma flow with the earth's magnetic field in a larger scale; and a semi-annual wave of the last one by the varying angle of attack of this flow against the earth's dipole axis. (W.D.M.)

12954 PHASE CHANGES IN THE 27 DAY TYPE OF INTENSITY VARIATION OF PRIMARY COSMIC RAYS FROM JANUARY 1955 TO JANUARY 1961. A. Fréon (Centre National de la Recherche Scientifique, Paris). J. Phys. Soc. Japan, 17: Suppl. A-II, 418-21(Jan. 1962).

It is well known that 27-day recurrent variation of cosmic radiation presents long periods of stability in correlation with long-life high-activity regions of the sun. These variations have been previously studied during the last solar activity maximum (Oct. 1956 to Dec. 1958) using data from two neutron monitors located at Pic-du-Midi, France, and Port-aux-Francais, Kerguélen Island. Results are presented from a study of these recurrent variations for the Jan. 1955 to Jan. 1961 period. (W.D.M.)

12955 THE RECOVERY CHARACTERISTICS OF FORBUSH DECREASES AND THE CONFIGURATION OF THE ASSOCIATED SOLAR EMISSION. I. Escobar, N. W. Nerurkar, O. Troncoso, and M. Zubieta (Universidad Mayor de San Andres, La Paz, Bolivia). J. Phys. Soc. Japan, 17: Suppl. A-II, 422-7(Jan. 1962).

Forbush decreases accompanying single magnetic storms are found on the average to recover fast or slow depending on whether the latter are strong or weak. In addition, the recovery rates of the mixed Forbush decreases appear to be related with the volume occupied in space by the emission associated with magnetic storms. This emission is therefore suggested to occur either in narrow cones or omnidirectionally. It is shown that it not only explains satisfactorily a wide range of recovery rates of Forbush decreases viz. few hours to two weeks but also helps in understanding the total absence of magnetic storms after some large solar disturbances. (auth)

12956 A STUDY OF THE RIGIDITY AND CHARGE DEPENDENCE OF PRIMARY COSMIC RAY TEMPORAL VARIATIONS. Frank B. McDonald (NASA, Goddard Space Flight Center, Greenbelt, Md.) and William R. Webber. J. Phys. Soc. Japan, 17: Suppl. A-II, 428-35(Jan. 1962).

The rigidity spectra and intensity of H, He, Be, B, C, N, and O of the galactic cosmic radiation have been measured over a period extending from solar minimum through the recent period of maximum activity. The hydrogen and helium data have been previously published. However, they are reviewed here and further conclusions regarding these studies are presented. In addition, comparison is made with the results of other experiments in this area. The flux and rigidity spectra of Be–O were measured on three high altitude balloon flights. Excellent charge resolution was obtained. It is observed that the light and medium nuclei display the same relative rigidity spectra throughout the solar cycle as do the protons and alphas. This conclusion is valid only in the region studied ($E > 400$ Mev/nuc) and one may well expect striking variations at lower values of heavy primary kinetic energy. The ratio of light to medium nuclei was not observed to vary appreciably over the solar cycle. (auth)

12957 FLUX AND ENERGY SPECTRA OF PRIMARY COSMIC RAY PROTONS FROM 70 TO 400 Mev. Rochus Vogt (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-II, 436-40(Jan. 1962).

A study of the low-energy portion of the primary cosmic-ray proton spectrum was made in August and September 1960. The observations took place in three high altitude balloon flights at geomagnetic latitudes $\lambda \geq 73°N$. A significant flux of primary protons was detected with energies below 500 Mev, which previously had been considered absent. Fluxes and energy spectra of these particles are given and their possible origins are discussed. (auth)

12958 SECULAR VARIATION OF THE COSMIC-RAY EQUATOR AND THE LATITUDE KNEE AT SEA LEVEL. Masahiro Kodama (Inst. of Physical and Chemical Research, Tokyo), Shin Fukushima, and Tadao Makino. J. Phys. Soc. Japan, 17: Suppl. A-II, 441-4(Jan. 1962).

During 1956-61 eight latitude surveys of cosmic-ray intensity were carried out along the same ship route between Japan and the Antarctic. A fixed position of the cosmic ray equator at 107°E found throughout the surveys, 6.1 ± 0.2°N geographic latitude, suggests few distortion effects of the geomagnetic field on cosmic rays due to the interaction of the dipole field with interplanetary medium. A fixed position of the latitude knee at 30°E found throughout the surveys, 35.4 ± 0.4°S geomagnetic latitude, means that the knee around 30°E is subjected to the intense geomagnetic anomaly around Cape Town rather than some mechanism outside the earth's magnetic field. (auth)

12959 THE SECULAR VARIATION OF THE GEOMAGNETIC FIELD AND THE CUT-OFF MOMENTA. Ruth Gall (National Univ., Mexico and Instituto Nacional de la Investigacion, Cientifica, Mexico). J. Phys. Soc. Japan, 17: Suppl. A-II, 444-8(Jan. 1962).

The trajectories of cosmic particles, the cones, and the corresponding threshold momenta are calculated using a model of the geomagnetic field. The time correction is discussed which when applied to the standard centered dipole model gives the cutoff for the eccentric dipole model for a given year of observation. (W.D.M.)

12960 COSMIC RAY THRESHOLD RIGIDITIES. J. J. Quenby, G. J. Wenk, and C. J. Bland (Imperial Coll. of Science and Tech., London). J. Phys. Soc. Japan, 17: Suppl. A-II, 449-54(Jan. 1962).

Some calculations of threshold rigidities are presented which include recent work on the effect of the non-dipole field. It is concluded that: the dipole field prenumbra is still maintained in the geomagnetic field except between 10 and 20°; the threshold rigidities in the terrella field predicted by calculations using the treatment of Quenby and Webber do not significantly differ from those experimentally observed values; and the effect of an external uniform field is to increase the threshold rigidity at the equator if it is in the same sense as the dipole moment. (W.D.M.)

12961 ASYMPTOTIC DIRECTIONS AND CUT-OFF RIGIDITIES IN THE GEOMAGNETIC FIELD. K. G. McCracken (Massachusetts Inst. of Tech., Cambridge) and A. Fréon. J. Phys. Soc. Japan, 17: Suppl. A-II, 455-6 (Jan. 1962).

A simulation of the geomagnetic field using spherical surface harmonics up to and including the sixth degree is in markedly better agreement with observation than is the dipole approximation. A digital computer has been used to numerically integrate the equations of motion of a cosmic ray in one such simulation. It is concluded that the magnetic field as estimated from surface measurements is adequate to explain the observed cosmic ray effects even near the Cape Town anomaly and the Quenby and Webber approximation breaks down near the anomaly. (W.D.M.)

12962 THE ENERGY SPECTRUM AND THE ENERGY BALANCE OF COSMIC RADIATION. H. Komori (Yamanashi Univ., Kofu, Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 457-63(Jan. 1962).

The energy spectrum of cosmic radiation in the geomagnetic field sensitive region has been obtained taking account of the modified dipole field as the geomagnetic field, and of splash albedo which is considered only in the case of the proton. For example, the integral energy spectrum of the proton with the kinetic energy from 0.5 to 15 Bev is expressed by $0.353\ (Mc^2 + E)^{-1.6}$, where Mc^2 is the rest mass of the proton and E the kinetic energy in unit of Bev. The above spectrum is derived from the data of quiet solar years. Since the cutoff rigidity depends not only on the geomagnetic latitude but also on the geomagnetic longitude, the energy balance of cosmic rays at four stations, i.e., Saskatoon, Minneapolis, San Angelo, and Guam has been analyzed. Adopting the revised energy spectrum and taking account of the underestimation in the nuclear disintegration, one could expect a good agreement between the incident energy and the energy dissipated in the atmosphere at any place. If it is so, the fact that the pure dipole field does not well explain the phenomena would be also derived from this point of view. (auth)

12963 ON THE WORLD-WIDE DISTRIBUTION OF THE DAILY VARIATION OF THE COSMIC-RAY NEUTRON INTENSITY AND ITS VARIATION. Tsunekichi Kanno (Fukushima Univ., Japan) and Kazuaki Murakami. J. Phys. Soc. Japan, 17: Suppl. A-II, 460-3(Jan. 1962).

The world-wide distribution of T_m (the local time of maximum in the diurnal variation of cosmic ray intensity) was derived from the data during the period of IGY and was compared with that calculated theoretically. The following results were obtained. (1) Cosmic particles seem to have an anisotropy in the direction of 17 hr (L.T.) and to be modulated in the direction of 12 hr (L.T.) within the solar clouds in interplanetary space. (2) The lines of force of the geomagnetic field may be assumed to bend westwards in the outer space of the earth. (3) The cosmic-ray equator may be changing from time to time. (auth)

12964 SOLAR DIURNAL VARIATION OF COSMIC RAY INTENSITY. M. A. Pomerantz, S. P. Duggal, and K. Nagashima (Bartol Research Foundation of the Franklin Inst., Swarthmore, Penn.). J. Phys. Soc. Japan, 17: Suppl. A-II, 464-8(Jan. 1962).

The monthly mean diurnal variation vectors determined from neutron monitor data recorded by 47 stations during IGY are compared with the average for the entire period. The dispersions, σ_r and σ_ϕ, in amplitude and phase for the entire 18 month period are determined. The resultant long-term vector is significantly larger than the month-to-month scatter in amplitude. Comparison of the observations with theoretical calculations yields values for the parameters $m = 0.5$ and $P_1 = 6$ Gv for a spectral dependence of the type: $y = \Delta f(P)/f(P) \propto P^{-m}$, where $f(P)$ represents the differential magnetic rigidity spectrum of the primary cosmic radiation, and $\Delta f(P)$ is the variation in $f(P)$, for P greater than P_1. The direction of anisotropy is 16.6 hours local time. The amplitude of the diurnal variation appears to increase slowly from the equator to middle latitudes, followed by a rapid decrease toward the poles. An increase in the time of diurnal maximum from equator to pole is revealed. The significant longitude effect predicted by theory is confirmed by comparisons between pairs of stations. A larger amplitude is observed at mountain stations, in accord with the theoretical predictions. Since the expected altitude-dependence of phase is small, the quantitative comparison with the limited available experimental results is precluded. (auth)

12965 SOME CHARACTERISTICS OF THE DAILY VARIATION OF COSMIC RAY INTENSITY. R. P. Kane (Physical Research Lab., Ahmedabad, India). J. Phys. Soc. Japan, 17: Suppl. A-II, 468-71(Jan. 1962).

Isotropic changes in the mean level of cosmic-ray intensity can produce considerable distortions in the true form of the daily variation of cosmic-ray intensity. These can be corrected if the mean level is first estimated by averaging data for the same U.T. from stations spaced equally in geographic longitude and then substracted from the data of each station, and the residuals studied with respect to the local time of the corresponding station. Pressure-corrected neutron monitor data are given for Climax, Lincoln, Huancayo, Makerere, Lae, Yakulsk, and Götingen. (W.D.M.)

12966 DIRECTION OF THE COSMIC RAY DIURNAL ANISOTROPY. Arne Eld Sandstrom, Eric Dyring, and Stig Lindgren (Univ. of Uppsala). J. Phys. Soc. Japan, 17: Suppl. A-II, 471-6(Jan. 1962).

By means of inclined telescopes positioned at three points with geographical lat. 59.9°N, 67.8°N, and 80.1°N, it is shown that the direction of the flow of excess particles, responsible for the anisotropy, is parallel to the orbital plane of the Earth. During 1958, 1959, and 1960 it made a yearly mean with angle the Sun-Earth line, estimated to be 90° ± 20°. (auth)

12967 A NEW STUDY OF THE COSMIC RAY DIURNAL VARIATION IN RELATION TO GEOMAGNETIC ACTIVITY. Arne Eld Sandstrom (Univ. of Uppsala). J. Phys. Soc. Japan, 17: Suppl. A-II, 477-80(Jan. 1962).

A comparison is being made between three ways of grouping the days according to their K_p indices. The cosmic ray diurnal variation on the most disturbed days is seriously affected by U.T. variations, the latter sometimes obliterating the true diurnal variation. Major phase shifts, not correlated with geomagnetic activity, are also a disturbing factor, although of less importance. The phase of the diurnal variation decreases with increasing geomagnetic activity. This is in accordance with an explanation offered in previous papers. (auth)

12968 SOLAR DIURNAL VARIATION OF COSMIC RAYS UNDERGROUND NEAR THE GEOMAGNETIC EQUATOR. Victor H. Regener (Univ. of New Mexico, Albuquerque). J. Phys. Soc. Japan, 17: Suppl. A-II, 481-3(Jan. 1962).

In an earlier experiment at Chacaltaya it was shown that the vertical flux of mesons (μ) at a depth of 30m water equivalent has a 24-hr diurnal variation with an amplitude of about 0.3% and with a maximum at about 1500 mean solar time. Results are presented from two large transistorized plastic scintillator telescopes operated in 1960 and 1961. One of these was inclined east, the other west, for the purpose of checking the terrestrial or extraterrestrial origin of the diurnal origin. (W.D.M.)

12969 THE DIURNAL VARIATION OF THE INTENSITY OF THE NUCLEONIC COMPONENT DURING FORBUSH DECREASES. J. B. Crowden and P. L. Marsden (Univ. of Leeds, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-II, 484-6 (Jan. 1962).

It has been suggested that there are two types of solar streams modulating the intensity of the cosmic radiation, one being wide and of low magnetic field strength causing the normal diurnal variation, the second narrower and having a stronger field causing Forbush decreases when the stream envelops the earth. It is reasonable to expect that streams of this second type may cause an anomalous diurnal variation while the earth is enveloped and to investigate this possibility an analysis is made of the diurnal variation of the intensity of the nucleonic component during 38 decreases of intensity for Leeds and Deep River and at Huancayo for 26 decreases. (W.D.M.)

12970 A LUNAR COSMIC RAY INTENSITY VARIATION. [PART] II. E. Bagge and O. Binder (Inst. for Pure and Applied Nuclear Physics, Kiel). J. Phys. Soc. Japan, 17: Suppl. A-II, 486-92(Jan. 1962).

By averaging the pressure corrected meson and neutron intensity data for Kiel (10°08'52" E/54°20'28" N geomagnetic latitude) from July 1957 to June 1961, the relative amplitudes for the mean meson vs neutron lunar day intensity wave were obtained as 0.012 vs 0.025% of the mean intensities. The maxima occur at about 12-14 hours after moon culmination at Greenwich. There are also indications for second harmonics in these waves. (auth)

12971 A SUMMARY OF SECULAR VARIATIONS OF COSMIC RAYS. H. V. Neher (California Inst. of Tech., Pasadena). J. Phys. Soc. Japan, 17: Suppl. A-II, 492-9 (Jan. 1962).

The secular or 11-year changes that occur in galactic cosmic rays are discussed and it is concluded that: (1) there is a large change during a solar cycle of the cosmic ray particles reaching the vicinity of the earth; (2) there is nearly an inverse relationship between general solar activity and cosmic ray intensity; (3) the lower energy particles are affected much more than those of higher energy; (4) throughout most of the solar cycle there exists a knee in the latitude curve at high altitudes; and (5) cosmic ray intensity is not exactly anticorrelated with general solar activity as measured by Zurich sunspot numbers but lags solar activity by 6 to 12 months. (W.D.M.)

12972 REVIEW OF COSMIC RAY DAILY VARIATION AND GEOMAGNETIC EFFECTS. Vikram Sarabhai (Physical Research Lab., Ahmedabad, India). J. Phys. Soc. Japan, 17: Suppl. A-II, 500-3(Jan. 1962).

In discussing the daily variation of cosmic rays, local time effects are considered. These are not only diurnal, but often involve a semidiurnal variation as well, particularly at low latitudes. Areas discussed include local time effects and anisotropy of cosmic rays, solar anisotropy and declination, solar and terrestrial relationships of the daily variation, geomagnetic effects, and the lunar daily variation. (W.D.M.)

12973 THE COSMIC RAY INTENSITY GRADIENT IN SPACE DURING SOLAR MODULATION. J. A. Simpson, C. Y. Fan, and Peter Meyer (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-II, 505-7(Jan. 1962).

Measurements of cosmic radiation intensity have been made to ~0.1 a.u. from the earth in Pioneer V for investigating the heliocentric properties of the eleven year and Forbush decrease modulations of cosmic ray intensity by magnetic fields in interplanetary space. It is shown that during a Forbush decrease at 0.03 a.u. the cosmic ray spectrum undergoes a sudden change wherein approximately 10% of the total flux (mostly low energy particles) is removed from the spectrum. A second decrease at 0.1 a.u. (30 days later) shows that this low energy component does not return to the vicinity of Pioneer V. It is shown that this change in spectrum is important for determining the gradient of cosmic ray intensity in space at the time of solar maximum. The gradient for the eleven year intensity variation is (0.0 ± 2.0)%/0.1 a.u. This result shows that if the cosmic ray flux at solar minimum approximates the galactic flux of cosmic rays, then the main heliocentric gradient in space lies beyond the orbit of the Earth. (auth)

12974 ATMOSPHERIC EFFECTS ON THE COSMIC-RAY MESON INTENSITY. Masami Wada (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Japan, 17: Suppl. A-II, 508-11(Jan. 1962).

The total barometer coefficient as a function of cut-off momentum and zenith angle of incident mesons as well as of latitude and altitude of observatory is calculated theoretically to find the coefficients of meson monitors at existing observatories. Statistical analysis by using the data obtained at Tokyo is carried out. The total barometer coefficient is $-(0.147 \pm 0.003)\%$/mb which is in good agreement with theoretical value. From this value, the coefficient for sea level monitors at high latitudes is found to be -0.17%/mb. The partial temperature coefficients for sea level mesons calculated theoretically by Dorman and by Maeda are examined statistically. No significant difference in functional form with respect to the atmospheric depth is found. The same examination shows that the mean mass temperature can be used instead of theoretical functions. The temperature coefficients obtained statistically are $-(0.255 \pm 0.009)\%/°C$ for the mean mass temperature. The correction factors are 0.84 ± 0.12 for Dorman's, and 1.10 ± 0.13 for Maeda's function. (auth)

12975 ATMOSPHERIC EFFECTS ON THE SEA LEVEL C.R. INTENSITY. Stig Lindgren (Univ. of Uppsala). J. Phys. Soc. Japan, 17: Suppl. A-II, 511-15(Jan. 1962).

An experimental study of the atmospheric modulation of the meson intensity could be based on essentially two types of regression equations. The first type assumes that most of the mesons are produced in a layer close to the 150 mb level. The second type takes into consideration the meson production from the top of the atmosphere down to the ground. The variations of ground meson intensity due to primary intensity fluctuations have to be eliminated in a study of the modulation effects due to the atmosphere. Two methods for doing this are discussed. (W.D.M.)

12976 NEUTRON PRODUCTION IN LEAD BY COSMIC RAY PROTONS. E. B. Hughes (Univ. of Leeds, Eng.), P. L. Marsden, M. A. Meyer, and A. W. Wolfendale. J. Phys. Soc. Japan, 17: Suppl. A-II, 516-17(Jan. 1962).

The average number of evaporation neutrons produced by the interaction of protons in lead has been determined for protons of momenta 0.3 to 150 Bev/c. A magnetic spectrograph was used at sea level to select protons of known momenta up to a maximum detectable value of 150 Bev/c. (W.D.M.)

12977 MULTIPLE NEUTRON PRODUCTION IN AN IGY NEUTRON MONITOR. P. Fieldhouse, E. B. Hughes, and P. L. Marsden (Univ. of Leeds, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-II, 518(Jan. 1962).

Data are reported on multiple production of evaporation neutrons in the lead lattice of a neutron monitor by cosmic radiation at sea level. It is shown that 77% of the detected neutrons are produced by interacting neutrons, 14.8% by protons, 6.8% by captured muons, and about 1% by muons interacting in flight. (W.D.M.)

12978 SOME EXPERIMENTS WITH A MOBILE NEUTRON MONITOR. J. Phillips (Univ. of Tasmania, Hobart, Australia) and N. R. Parsons. J. Phys. Soc. Japan, 17: Suppl. A-II, 519-23(Jan. 1962).

A series of measurements at Hobart at different altitudes using a cosmic-ray neutron monitor in a mobile laboratory has yielded a value of 135 g cm^{-2} for the attenuation length in air of the nucleonic component during September 1960-February 1961. The measurements also reveal significant effects of sky obscuration by nearby hills on the monitor counting rate and such screening effects are used in an experimental determination of the zenith angle dependence of the fast nucleon intensity. A brief discussion is given of changes observed in the attenuation length during the solar flare events of November 1960. (auth)

12979 SOME ASPECTS OF THE INTERNAL STRUCTURE OF A SOLAR FLARE PLASMA CLOUD. C. P. Sonett (National Aeronautics and Space Administration, Washington, D. C.), Leverett Davis, Jr., and P. J. Coleman, Jr. J. Phys. Soc. Japan, 17: Suppl. A-II, 524-7(Jan. 1962).

During the passage of Pioneer V through the plasma generated by the solar flare sequence of March 31-April 1, 1960, a null in the interplanetary magnetic field, having a scale of $\sim 3 \times 10^{10}$ cm, was noted. Arguments are presented to show the consistency of this event with various plasma-field configurations. On these bases, possible models of the interior of a solar flare plasma cloud are presented. Models having a neutral layer seem more plausible than those having isolated neutral points or field-free plasma inclusions. (auth)

12980 HYPERWAVES, SHOCK-LIKE PHENOMENA IN THE OUTER EXOSPHERE. C. P. Sonett (National Aeronautics and Space Administration, Washington, D. C.). J. Phys. Soc. Japan, 17: Suppl. A-II, 528-31(Jan. 1962).

An unusual feature of the geomagnetic field observed by Pioneer I at geocentric altitudes of 12.3 to 14.6 earth radii was the appearance of sharp crested magnetic waves having many similarities to the collisionless magnetoacoustic shock waves studied by Adlam and Allen; Davis, Lüst and Schlüter; Banos and Vernon, and others. These waves appear to propagate toward regions of increasing field and to transport large fluxes of momentum density. Arguments are given to show that they are capable of convecting plasma inward into the exosphere. These waves may also contribute appreciably toward heating of the exosphere local to their position. The frontal thickness of these waves is orders less than the mean free path and they thus tend toward a Larmor radius limitation in thickness. The observations are consistent with the existence of "collisionless shock" waves in gyrotropic plasmas of astrophysical scale and argue for their existence generally in the galaxy. Their significance as a cosmic ray accelerator requires further study. (auth)

12981 EJECTION OF PLASMA WITH THE MAGNETIC FIELD AND LOW-ENERGY SOLAR COSMIC RAYS FROM THE REGION OF CHROMOSPHERIC FLARES. A. S. Dvoryashin. J. Phys. Soc. Japan, 17: Suppl. A-II, 532-4 (Jan. 1962).

During the period of 1957-1960 the relationship between the polar-cap absorption and magnetic storms with sudden commencement (SC) was examined in connection with solar flares accompanied by the type IV solar radio outburst. From the analyses of observed data, conclusions were made about the generation of the high energy protons (~10-100 Mev) on the sun. It is supposed that the ejection of high-energy protons from active region takes place simultaneously with the ejection of the plasma which causes magnetic storms with sudden commencement. From the considerable time-delay in the arrival of high energy protons, the duration and isotropy of the precipitation of the protons in the polar cap conclusions were made about the existence of an approximately radial magnetic field with irregularities in interplanetary space. (auth)

12982 SOME FEATURES OF CHROMOSPHERIC FLARES AND ITS CORRESPONDING ACTIVE REGIONS RESPONSIBLE FOR FORBUSH-EFFECT. B. Vladimirskii

(Vladimirsky). J. Phys. Soc. Japan, 17: Suppl. A-II, 534-7(Jan. 1962).

An attempt is made to reveal some features of solar flares and their active regions by analyzing flares of importance 2^+ and more responsible for Forbush decrease. Data of IGY are used. It is shown that solid angle of outburst exciting Forbush-effect is the same as from magnetic storm data. A dependence between amplitude and duration of effect in cosmic rays and longitude of corresponding solar flare is revealed. The flares connected with Forbush-effect have larger duration, area in the maxima, and larger intensity in H_α. There is no dependence between strengths of the magnetic field in active regions and amplitude of effect in cosmic rays. (auth)

12983 ON THE STREAMING OF A PLASMA THROUGH THE GEOMAGNETIC FIELD. Erik T. Karlson (AB Atomenergi, Stockholm). J. Phys. Soc. Japan, 17: Suppl. A-II, 538-42(Jan. 1962).

Alfvén's electric field theory of magnetic storms and aurorae is based on the assumption that the sun emits beams of ionized gas. The motion of such a beam through the interplanetary magnetic field is associated with an electric field across the beam. If the motion of such a beam, when it enters the geomagnetic field, is analyzed by means of the equations of motion for single particles, the results give a fairly good picture of magnetic storms and aurorae. As the motion of the particles in the equatorial plane produces space charges which are not taken into account, these results are valid only if these space charges leave the equatorial plane along the magnetic lines of force. It is not evident, however, that the charged particles could leave the equatorial plane so fast that the electric field is influenced. The motion of charged particles in the equatorial plane is studied under the assumption that no space charges leave this plane along the lines of force. The main results from this treatment agree qualitatively with Alfvén's results. (auth)

12984 THE EFFECT OF SOLAR DISTURBANCES AND THE GALACTIC MAGNETIC FIELD ON THE INTERPLANETARY GAS. Leverett Davis, Jr. (California Inst. of Tech., Pasadena). J. Phys. Soc. Japan, 17: Suppl. A-II, 543-5 (Jan. 1962).

It is suggested that a model of interplanetary storms be considered in which the gas emitted from the sun is added to a basic, previously flowing solar wind whose velocity varies from week to week, depending on previous solar activity. Thus the shock produced by the added gas can be weaker, the continuous supply of pressure on the back side of the shock can be smaller, and there will be less tendency to spread to the back side of the sun than if the shock were in a stationary medium. It is suggested that the solar plasma may produce a cavity of radius 5-20 a.u. in the galactic magnetic field; this radius being deduced with relatively few assumptions from the observed effect of the solar plasma on the geomagnetic field. The boundary of this cavity should be unstable, allowing bubbles of gas to escape into the galactic field and exciting Alfvén waves that run along the galactic field away from the cavity. Thus galactic cosmic rays trapped inside the cavity are pumped out and the diffusion is impeded. It seems possible that this mechanism may account for the 11-year cycle in cosmic-ray intensity. (auth)

12985 MAGNETIC FIELD MEASUREMENTS WITH THE EXPLORER X SATELLITE. J. P. Heppner, N. F. Ness, T. L. Shillman, and C. S. Scearce (National Aeronautics and Space Administration, Greenbelt, Md.). J. Phys. Soc. Japan, 17: Suppl. A-II, 546-52(Jan. 1962).

The results of a preliminary analysis of Explorer X magnetic field data are summarized. Explorer X (1961 Kappa), launched at 15:17 GMT, March 25, 1961, was instrumented with a rubidium vapor magnetometer and two flux gate, saturable core magnetometers for field measurements, a plasma probe for measurement of the flux of low energy protons, and an optical aspect system for precise determination of the satellite's orientation relative to the sun. (auth)

12986 SOME THEORETICAL ASPECTS OF INTERPLANETARY PLASMA. R. Luest (Max-Planck-Institut für Physik und Astrophysik, Munich). J. Phys. Soc. Japan, 17: Suppl. A-II, 560-2(Jan. 1962).

Since the intensity and the velocity of the solar wind are determined by the physical states of the solar atmosphere, the conditions in these regions are discussed to indicate the source of the energy of corpuscular radiation. Some other observational evidence is mentioned, especially that from comets which seems to be important for an understanding of the interplanetary plasma. Theoretical conclusions are discussed. (W.D.M.)

12987 INTERPLANETARY DYNAMICS AND COSMIC RAY MODULATION. E. N. Parker (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-II, 563-7(Jan. 1962).

Recent observations in space confirm the earlier inference from the analysis of comet tails that there is a continual outward flow of solar corpuscular radiation from the sun. It is concluded that the enhanced solar corpuscular radiation following a large solar flare is the blast wave from the hydrodynamic explosion of the enhanced corona. (W.D.M.)

12988 PROPAGATION OF SOLAR PARTICLES AND THE INTERPLANETARY MAGNETIC FIELD. Constance Warwick (National Bureau of Standards, Boulder, Colo.). J. Phys. Soc. Japan, 17: Suppl. A-II, 571-2(Jan. 1962).

Careful study of solar activity near the time of PCA events reveals peculiarities in the propagation characteristics of the 30- to 100-Mev solar protons responsible for the absorption. Other characteristics of solar cosmic-ray increases, PCA events, and geomagnetic storms are summarized. (W.D.M.)

12989 PROPAGATION OF SOLAR PARTICLES THROUGH INTERPLANETARY MAGNETIC FIELDS. Tatsuzo Obayashi (Radio Research Labs., Hiraiso, Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 572-4(Jan. 1962).

All available information on solar flares including radio emissions, polar cap absorptions, geomagnetic storms, and cosmic ray storms during the period from July 1957 to Dec. 1960 has been examined. Summarized results are presented. (W.D.M.)

12990 INTENSITY-TIME RELATIONSHIP OF COSMIC RAY UNUSUAL INCREASE, NOT CHARACTERIZED BY IMPACT ZONE EFFECTS. Kazuo Nagashima (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 575-7 (Jan. 1962).

Under an assumption that the solar-produced cosmic rays are able to reach the earth only after the diffusion process through interplanetary space, the intensity-time relationship at an observed point is studied theoretically. By comparison of the observed intensity-time relationship with the theoretical one, it is possible to determine the initial time and the injection period of cosmic rays which are injected into interplanetary space from the source, to determine the diffusion constant with which the cosmic rays propagate in space, and to estimate the total number of cosmic rays injected during the injection period. (auth)

12991 ON THE MECHANISM OF THE COSMIC-RAY STORM. Masatoshi Kitamura (Meteorological Research Inst., Tokyo). J. Phys. Soc. Japan, 17: Suppl. A-II, 578-82(Jan. 1962).

On the basis of the observed facts of the cosmic-ray storm, a model of the mechanism of the cosmic-ray storm is proposed, considering the connection with other related phenomena, such as the solar and terrestrial phenomena. As a result of the investigation, it is concluded that the essential mechanism of the cosmic-ray storm is the deceleration of the cosmic-ray particles in the magnetic cloud due to its expansion. Moreover, it is shown that DS of the cosmic-ray storm is originated by the same magnetic cloud responsible for the world wide decrease of the cosmic-ray intensity due to the anisotropy of the expansion velocity of the magnetic cloud. (auth)

12992 FORBUSH DECREASES PRODUCED BY DIFFUSIVE DECELERATION MECHANISM IN INTERPLANETARY SPACE. S. F. Singer, H. Laster, and A. M. Lenchek (Univ. of Maryland, College Park). J. Phys. Soc. Japan, 17: Suppl. A-II, 583-8(Jan. 1962).

Transient decreases in the intensity of galactic cosmic radiation are known to be associated with the arrival at the earth of large clouds of magnetized solar plasma. The large scale of the phenomenon indicates that the clouds expand significantly while crossing the solar system. An interpretation is given based on the assumption that the plasma is magnetically turbulent. Cosmic rays which enter the cloud then execute a random-walk motion in space. While within the expanding cloud they must lose energy in an inverse Fermi mechanism and by betatron action in the weakening magnetic field. The energy spectrum within the cloud is depressed below the galactic spectrum. The spectrum is calculated in the isotropic approximation using age-diffusion theory, considering only the effects of spatial diffusion and energy loss. Convection is neglected. Several prominent features of observed decreases are thereby accounted for. (auth)

12993 MODULATION OF THE COSMIC RAY INTENSITY BY THE INTERPLANETARY MAGNETIC FIELD. H. Elliot (Imperial Coll. of Science and Tech., London). J. Phys. Soc. Japan, 17: Suppl. A-II, 588-94(Jan. 1962).

There exists a number of rather different models of the interplanetary field, each of which tends to emphasize some particular characteristic as the prime cause of the cosmic ray intensity variations. These models are discussed and an attempt is made to construct a simple semi-quantitative model of the interplanetary magnetic field which would incorporate some of these ideas and which would at the same time be capable of explaining the 11-yr intensity variation, Forbush decrease, and the solar daily variation. (W.D.M.)

12994 MORPHOLOGY OF SOLAR FLARE EFFECTS ON COSMIC RAYS AND SUB-COSMIC RAYS. Masahiro Kodama (Inst. of Physical and Chemical Research, Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 594-600(Jan. 1962).

Morphological studies of energetic solar protons are presented in an energy range of Mev to Bev by using cosmic ray records and polar cap absorption data. The solar protons could be classified by order of energy into the four groups: (1) cosmic ray unusual increase, (2) cosmic ray small increase and polar cap absorption of (3) fast and (4) slow types, being classified, respectively, in terms of the propagation time of the particles from the sun toward the earth. A clear distinction is recognized on their characters between a group of the unusual increase and the fast-type PCA and another group of the small increase and the slow-type PCA. These two groups are related to different solar regions where different accelerations of particles occur. This conclusion is based on characteristics of the solar radio noise outbursts associated with these solar proton events and also solar cycle dependencies of the events. (auth)

12995 THE PROPAGATION OF SOLAR PARTICLES TO THE EARTH. Thomas Gold (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Japan, 17: Suppl. A-II, 600-6(Jan. 1962).

Some considerations that affect the discussions of models of fields and particle motions in interplanetary space are summarized. (W.D.M.)

12996 EMISSION FROM THE SUN, AND TRANSMISSION OF RADIATION THROUGH THE INTERPLANETARY SPACE. T. Gold (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Japan, 17: Suppl. A-II, 607-9(Jan. 1962).

A short discussion is presented on the theory of magnetic storms and phenomena on the sun which precede these storms. (W.D.M.)

12997 PARTICLES IN THE MAGNETOSPHERE. S. F. Singer (Univ. of Maryland, College Park). J. Phys. Soc. Japan, 17: Suppl. A-II, 609-11(Jan. 1962).

The bulk of the particles in the magnetosphere up to some 10-15 earth radii have thermal energies corresponding to the temperature at the base of the exosphere, about 1500°. The fast particles which relate to the magnetosphere are those which are trapped in the geomagnetic field (high energy protons, high energy electrons, low energy electrons, low energy electrons, and magnetic storm belt particles). (W.D.M.)

12998 RADIATION BELT. Satio Hayakawa (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-II, 612-13(Jan. 1962).

Remarks are presented on the effects of magnetic disturbances on the radiation belts, especially on the E-3. The following conclusions are drawn: (1) the decrease of the intensity of electrons with energies greater than 1 Mev takes place in association with the main phase; (2) the increase of the intensity of electrons of energies <1 Mev in the same period seems to be inferred from x rays observed by Winckler; and (3) the increase of electron intensity in a wide range occurs preferentially near the equator when the magnetic field shows a rapid variation. (W.D.M.)

12999 RADIATION BELT. S. N. Vernov (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-II, 613-14(Jan. 1962).

A short discussion is presented on the inner and outer radiation belts. The acceleration mechanism active in the outer belt is considered. (W.D.M.)

13000 RADIATION BELT—RESULTS OF THE DIRECT MEASUREMENTS OF INTERPLANETARY PLASMA AND MAGNETIC FIELD BY EXPLORER X. B. Rossi (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. A-II, 615-16(Jan. 1962).

It is not yet clear whether the conditions recorded by Explorer X beyond 22 earth radii were typical of interplanetary space or whether they were still affected by the earth's magnetic field. If the former assumption is correct, the observations of Explorer X indicate that the interplanetary plasma is divided into regions of two different types with linear dimensions of the order of 10^{11} cm, separated by sharp boundaries. Measurements taken by Explorer X are summarized. (W.D.M.)

13001 MAGNETIC EFFECT. E. H. Vestine (RAND Corp., Santa Monica, Calif.). J. Phys. Soc. Japan, 17: Suppl. A-II, 616-18(Jan. 1962).

An attempt is made to describe how the magnetic effects in the earth storm arise. These consist of the reverse impulse, the increase known as the sudden commencement, its continuation as the initial phase of the storm for an hour or so, after which a much larger diminution in field occurs during some hours, followed by a slow recovery to normal over a period of days. (W.D.M.)

13002 AURORAL PHENOMENA. S. Chapman (Univ. of Alaska, College; Univ. of Colorado, Boulder; and Univ. of Michigan, Ann Arbor). J. Phys. Soc. Japan, 17: Suppl. A-II, 619-20(Jan. 1962).

Auroral light comes mainly from ionospheric atoms and molecules, especially from those of oxygen and nitrogen. They are excited and ionized by primary particles which descend along the lines of geomagnetic force and enter the ionosphere. A brief review of auroral phenomena is given. (W.D.M.)

13003 TRANSMISSION OF HYDROMAGNETIC WAVE TO THE EARTH. Ken-ichi Maeda (Kyoto Univ.). J. Phys. Soc. Japan, 17: Suppl. A-II, 620-2(Jan. 1962).

Basic characteristics of hydromagnetic waves, which have been clarified by theoretical studies, are summarized. Descriptions are given on the process of transmission of hydromagnetic disturbances to the earth's surface, which are generated by impacts of the solar plasma wind at the interface between geomagnetic cavity and interplanetary space. Finally some problems for future study and some possible experiments by satellite are briefly discussed. (auth)

13004 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM, KYOTO, 4-15 SEPTEMBER, 1961. VOLUME III. COSMIC RAYS. J. Phys. Soc. Japan, 17: Suppl. A-III, 1-544(Jan. 1962).

Papers on the following aspects of cosmic radiation are presented: composition, primaries, origin, extensive air showers, μ mesons, jet showers, high-energy theory, future prospect, and astrophysics. Separate abstracts have been prepared for 123 papers; 14 have been previously abstracted for NSA. (A.G.W.)

13005 SOME EXPERIMENTAL ATTEMPTS TO DETECT COSMIC GAMMA RAYS. W. L. Kraushaar and G. W. Clark (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. A-III, 1-5(Jan. 1962).

A satellite experiment designed to detect γ rays of energy 50 Mev and over such as would arise from the decay of π^0 mesons is described. During about 23 hr of useful observing time, 127 events occurred which could be γ rays. Analysis of arrival direction data, possible sources of background, and the γ-ray source strength are discussed. (A.G.W.)

13006 SOME PROPERTIES OF THE PRIMARY COSMIC RAY ELECTRONS. Peter Meyer and Rochus Vogt (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-III, 5-8(Jan. 1962).

Measurements carried out at balloon altitudes over Ft. Churchill, Manitoba, provide data on the production of electrons at the sun during the Sept. 3, 1960, solar flare and on the short-term intensity variation of the primary electron flux during a Forbush-type decrease which began on Sept. 4, 1960. Results indicate that the flare did not lead to an emission of electrons and that the electrons observed at the earth have a history similar to that of galactic protons. The evidence, therefore, points to a galactic origin of primary electrons. (A.G.W.)

13007 THE FLUX OF PRIMARY PROTONS AND HELIUM NUCLEI NEAR THE GEOMAGNETIC EQUATOR. V. K. Balasubrahmanyan, S. M. Ganguli, G. S. Gokhale, N. Kameswara Rao, P. K. Kunte, M. G. K. Menon, and M. S. Swami (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 8-12(Jan. 1962).

Balloon flights were made from Hyderabad, India, to determine the flux of primary protons and helium nuclei at the top of the atmosphere near the geomagnetic equator. Measurements were made with both Cherenkov-scintillation counter telescopes and nuclear research emulsions. The flux of helium nuclei was found to be 19.7 ± 1.2 particles/m^2/sterad/sec. The proton flux determined by the Cherenkov-scintillator technique was 110 ± 3 particles/m^2/sterad/sec and that determined by the nuclear-emulsion technique was 87 ± 12 particles/m^2/sterad/sec. (A.G.W.)

13008 PRIMARY COSMIC-RAY α-PARTICLES OVER NORTH AMERICA. M. W. Friedlander (Washington Univ., St. Louis). J. Phys. Soc. Japan, 17: Suppl. A-III, 13(Jan. 1962).

In high-altitude balloon flights over North America, nuclear emulsions were used to study the characteristics of the primary helium nuclei in cosmic radiation. On Feb. 8, 1959, at 41°N the helium-nuclei flux was found to be 76 ± 4 particles/m^2/sterad/sec. On Aug. 3, 1958, it was 88 ± 8 particles/m^2/sterad/sec at 49°N and 135 ± 8 particles/m^2/sterad/sec at 61°N. (A.G.W.)

13009 THE ENERGY SPECTRUM OF NUCLEI WITH CHARGE $Z \geq 13$ IN THE PRIMARY COSMIC RADIATION. K. A. Neelakantan and P. G. Shukla (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 20-2(Jan. 1962).

The energy spectrum of nuclei with charge $Z \geq 13$ was determined in the energy range 1.5 Bev/nucleon to 15 Bev/nucleon. Measurements were made in nuclear emulsions by a knock-on electron technique. It was concluded that, within experimental error, the energy spectra of all nuclei have the same form. (A.G.W.)

13010 RELATIVE ABUNDANCES OF THE HEAVY NUCLEI OF THE GALACTIC COSMIC RADIATION. F. W. O'Dell, M. M. Shapiro, and B. Stiller (Naval Research Lab., Washington, D. C.). J. Phys. Soc. Japan, 17: Suppl. A-III, 23-9(Jan. 1962).

For a decade, controversy has persisted over the question: does the galactic cosmic radiation incident upon the top of the atmosphere contain a significant fraction of Li, Be, and B? This question has an important bearing on the "age" of the cosmic radiation and on its propagation through interstellar space. To resolve the problem, an emulsion experiment was designed to provide (a) higher statistical weight, (b) exposure at greater altitude, and (c) verifiable charge identification by employing several independent methods of ionization measurement in emulsions of different sensitivities. The balloon, launched at geomagnetic latitude 41°N, on March 9, 1958, floated at an atmospheric depth of 2.7 g/cm^2 for 7½ hours. Over 900 tracks were analyzed, and the L tracks (due to Li, Be, and B) were well resolved from the heavier (S) tracks. The ratio $(L/S)_0$ at the top of the atmosphere was found to be 0.18 ± 0.04, and $(H/M)_0 = 0.38 \pm 0.04$. The value 0.14 is considered a lower limit for $(L/S)_0$ since it was obtained by using the extremely large Rochester fragmentation coefficients P_{HL} and P_{ML} in extrapolating to the top of the atmosphere. The results demonstrate conclusively that Li, Be, and B comprise a significant proportion of the heavy primary nuclei, and that their relative cosmic-ray abundance is approximately 2×10^5 times their relative "universal" abundance. Relative

to carbon or oxygen, cosmic-ray nitrogen was found to be about one-half as abundant as previously supposed. (auth)

13011 THE STUDY OF THE COMPOSITION OF PRIMARY COSMIC RADIATION AT THE ALTITUDE OF 320 km. K. I. Alekseeva, L. L. Gabunia, G. B. Zhdanov, E. A. Zamchalova, M. I. Tretjakova, and M. N. Shecherbakova (Lebedev Inst. of Physics, Moscow and Moscow Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 30-4(Jan. 1962).

An emulsion stack was exposed for ~24 hr during the flight of the second space ship in Aug. 1960. An attempt to use an automatic apparatus in measuring the tracks obtained is described. The method appeared to be adequate for separation of the groups Li, Be, B and C, N, O. Relative intensities of nuclei with charge $Z = 3$ to $Z \geq 9$ are shown in a table. (A.G.W.)

13012 THE HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION AT SIOUX FALLS, S. D. H. Aizu (Northwestern Univ., [Evanston, Ill.]), E. Tamai, M. Koshiba, and E. Lohrmann. J. Phys. Soc. Japan, 17: Suppl. A-III, 34-7(Jan. 1962).

A balloon launched from Sioux Falls on Sept. 4, 1959, carried an emulsion stack to an altitude of 125,000 ft. The tracks obtained were measured, identified, and extrapolated to the top of the atmosphere. The energy spectra of the $L(3 \leq Z \leq 5)$, $M(6 \leq Z \leq 9)$, and $H(Z \geq 10)$ groups of nuclei are shown, and L/M and H/M ratios are given. (A.G.W.)

13013 HEAVY PRIMARY COSMIC RADIATIONS OBSERVED ON 11 SEPT., 1957, AT PRINCE ALBERT, CANADA. H. Aizu (Rikkyo Univ., Tokyo), I. Mito, Y. Fujimoto, S. Hasegawa, M. Koshiba, J. Nishimura, and K. Yokoi. J. Phys. Soc. Japan, 17: Suppl. A-III, 38-9(Jan. 1962).

The main results of analysis of the Prince Albert Stack are summarized briefly. The flux values of various heavy primary components and the flux ratios of light and heavy nuclei, respectively, to medium nuclei are shown in tables. (A.G.W.)

13014 SATELLITE INVESTIGATION OF TIME VARIATIONS OF HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. Martin A. Pomerantz (Franklin Inst., Swarthmore, Penna.) and Louis Witten. J. Phys. Soc. Japan, 17: Suppl. A-III, 40-3(Jan. 1962).

Data recorded during 8 months of operation of a detector of heavy nuclei ($Z \geq 6$) aboard the satellite Explorer VII (1959 Iota) have been analyzed in an investigation of temporal fluctuations in the flux and energy spectrum of this primary cosmic radiation. The integral energy spectrum was determined for each of 13 roughly equal (about a fortnight) intervals during the period October 1959-May 1960. The energy spectrum, expressed in the form $N(>E) = kE^{-\gamma}$, where N is the number of counts per hour, and E is the total energy is Bev/nucleon to the semi-monthly averages of data recorded in 1° intervals of geomagnetic latitude. The values of γ and k manifested significant changes during the period of the observations. The exponent γ in the power law expression for spectrum varied between 1.5 and 0.8. Changes in the shape of the spectrum were also evident in the range of $E \leq 3$ Bev/nucleon. Variations in the flux at fixed location appear to be correlated with fluctuations in the primary proton intensity, as observed by neutron monitor stations. In the vicinity of 30° geomagnetic latitude, −70° geomagnetic longitude, the mean ratio of the percentage changes in the intensities of the heavy nuclei and nucleonic component was approximately equal to 2. (auth)

13015 DETERMINATION OF PRIMARY COSMIC RAY NUCLEI WITH Z GREATER THAN 26 IN NUCLEAR EMULSIONS. G. Alvial (Universidad, Santiago, Chile). J. Phys. Soc. Japan, 17: Suppl. A-III, 44-8(Jan. 1962).

The charges of high-energy nuclei were computed from the density of small δ rays and from the mean free path between them. A table shows the number of heavy nuclei of high energy with charges between 25 and 31 found in a 200-plate emulsion stack exposed at 131,000 ft for 19 hr. (A.G.W.)

13016 He^3-NUCLEI IN THE PRIMARY COSMIC RADIATION. M. V. K. Appa Rao and M. F. Kaplon (Univ. of Rochester, N. Y.). J. Phys. Soc. Japan, 17: Suppl. A-III, 48-52(Jan. 1962).

The ratio $He^3/(He^3 + He^4)$ was determined in two high-altitude balloon flights carried out about a year apart. A constant sagitta scattering scheme used for mass separation is described. A table shows results for each flight calculated on both energy/nucleon and magnetic rigidity bases. (A.G.W.)

13017 FRAGMENTATION PARAMETERS INVOLVED IN THE COLLISIONS OF THE HEAVY NUCLEI OF THE PRIMARY COSMIC RADIATION OF CHARGE $Z \geq 6$ IN GRAPHITE. G. D. Badhwar, N. Durga Prasad, and B. Vijayalakshmi (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 55-8(Jan. 1962).

By studying the fragmentation parameters associated with collisions of the cosmic-ray heavy nuclei with graphite or a hydrogeneous material such as paraffin, it is possible to estimate the corresponding values in hydrogen by taking the differences. For this purpose, emulsions sandwiched between sheets of graphite and paraffin were exposed in balloon flights made from Hyderabad, India, during 1960. Results based on 109 interactions of $Z \geq 6$ in graphite are tabulated. (A.G.W.)

13018 ELECTRONS AND γ-RAYS IN THE PRIMARY COSMIC RADIATION. Peter Meyer (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-III, 60-2(Jan. 1962).

Recent experimental work concerned with the γ and electron components of the primary cosmic radiation is summarized. Consequences of these experimental results and prospects for future experiments are discussed briefly. (A.G.W.)

13019 PRESENT STATE OF KNOWLEDGE OF THE COMPOSITION OF THE PRIMARY COSMIC RADIATION. C. J. Waddington (Goddard Space Flight Center, Greenbelt, Md.). J. Phys. Soc. Japan, 17: Suppl. A-III, 63-8(Jan. 1962).

The data on the composition of the primary cosmic radiation reported at the 1962 International Conference on Cosmic Rays are summarized and related to data previously available. (A.G.W.)

13020 ISOTOPIC COMPOSITION. M. F. Kaplon (Univ. of Rochester, N. Y.). J. Phys. Soc. Japan, 17: Suppl. A-III, 68-73(Jan. 1962).

Reasons for studying the isotopic composition of cosmic radiation are considered briefly. Existing experimental results on the relative abundance of helium and carbon isotopes are summarized, and the meaning of these results is discussed. (A.G.W.)

13021 SPECTRUM AND ISOTROPY OF EAS. John Delvaille, Francis Kendziorski, and Kenneth Greisen (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Japan, 17: Suppl. A-III, 76-83, 76-83(Jan. 1962).

The number spectrum of EAS has been found to extend to showers of more than 10^{10} particles without noticeable increase in steepness. The logarithmic slope has some un-

certainty because of an unknown variation of lateral distribution near the axis with shower size; the corrected value of γ is about 1.7 for $6 \times 10^6 < N < 6 \times 10^9$ particles. Assuming a lateral distribution corresponding to an age parameter $s = 1$, the largest shower recorded had 2.6×10^{10} particles. Large showers ($N > 10^7$) seem to exhibit substantial anisotropy, but the statistical significance of this observation is not very great. The persistent feature is a pronounced minimum around 15 hours local sidereal time. In the showers of $6 \times 10^5 < N < 10^8$ such a minimum appeared associated with a large second harmonic (17%) in the Fourier amplitudes, while in the showers of $N > 10^8$ this minimum appeared to be associated with a large first harmonic (35%). A minimum in the third quadrant also appears in the MIT Agassiz data for showers of $N > 10^8$, and in the MIT Volcano Ranch data, as well as in Japanese data on "μ-rich" showers, "μ-less" showers, and multiple penetrating particles observed underground. Fourier analysis of the frequencies of smaller showers reveals no second harmonics, but a possibly significant first harmonic of amplitude about 0.4% with maxima in the range 13 to 20 hours local sidereal time, for EAS of $10^4 < N < 10^6$ particles. Because of the complexity of solar periodic atmospheric effects on EAS, this apparent anisotropy of the primaries may be spurious; but is is suspicious that many experimenters in different places on the earth have found maxima at approximately the same local sidereal time, both in the rates of small EAS and in the background cosmic-ray intensity. (auth)

13022 SPECTRA OF THE SIZE AND TOTAL NUMBER OF μ-MESONS IN EAS. I. Miura and H. Hasegawa Tokyo Univ. and Gakushuin Univ., Tokyo). J. Phys. Soc. Japan, 17: Suppl. A-III, 84-6(Jan. 1962).

The size spectrum of the extensive air showers in the size range $N = 3 \times 10^4$ to 10^8 and the spectrum of the number of μ mesons contained in each air shower were studied at sea level. It was concluded that the energy spectrum of cosmic rays has a break or changes its exponent within a decade of energy range corresponding to the size 10^5 unless the nature of nuclear interaction changes in a peculiar way at a certain energy. (A.G.W.)

13023 ARRIVAL DIRECTIONS OF THE MULTIPLE PENETRATING PARTICLES. S. Higashi, T. Kitamura, Y. Mishima, S. Miyamoto, H. Shibata, and Y. Watase (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 89-90 (Jan. 1962).

In about 3000 hr of observing time, 51 events of multiple penetrating particles were observed in a cloud chamber. When arrival directions of these events were plotted on celestial coordinates, there seemed to be some concentration of points on the morning side of sidereal time. Possible interpretations of the apparent anisotropy are considered briefly. (A.G.W.)

13024 ENERGY SPECTRUM AND STRUCTURE OF LARGE AIR SHOWERS. J. Linsley, L. Scarsi, and B. Rossi (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. A-III, 91-102(Jan. 1962).

Nineteen 3.3-m^2 plastic scintillation detectors in a hexagonal array covering 2 km^2 were used in this study. Methods of recording and analyzing data are discussed, and results are presented on the following: lateral distribution of particle density, the proportion of penetrating particles, variation of shower intensity and shower size with atmospheric depth, the primary cosmic ray energy spectrum, isotropy of primary cosmic radiation, and the largest shower recorded. (A.G.W.)

13025 NATURE OF PRIMARY COMPONENT OF COSMIC RAYS AND FLUCTUATION CHARACTER OF EAS. N. Gorjunov, L. G. Dedenko, and G. T. Zatsepin (Academy of Sciences, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 103-5(Jan. 1962).

Possible interpretations of the previously observed change of the exponent of the number spectra of cosmic showers at a primary energy of about 3×10^{15} ev are discussed in relation to the composition of primary particles. The importance of studying fluctuations in air showers as an aid in determining the composition of primary particles at high energies is pointed out. (A.G.W.)

13026 A SEARCH OF PHOTONS WITH THE ENERGY OF 10^{13} ev FROM DISCRETE SOURCES OF COSMIC RADIATION. A. E. Chudakov, V. I. Zatsepin, N. M. Nesterova, and V. L. Dadykin (Levedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 106-8(Jan. 1962).

The discrete radio sources Cygni A, Cassiopeiai A, and Tauri A were studied in an attempt to detect photons with energy $E \cong 10^{13}$ ev coming to earth from these objects. No conclusive evidence for the photons from any of the sources was found. (A.G.W.)

13027 PHOTOGRAPHY OF EXTENSIVE AIR SHOWERS IN CHERENKOV LIGHT. N. A. Porter (University Coll., Dublin) and D. A. Hill. J. Phys. Soc. Japan, 17: Suppl. A-III, 112-14(Jan. 1962).

An image-intensifier system triggered by amplified pulses from a 5-in. photomultiplier was used in an attempt to photograph Cherenkov light from cosmic showers. Ten of 32 photographs made showed bright spots 2-5° in diameter. The centers of the spots could be determined to an accuracy approaching 0.1° but the true direction of the shower could not be determined conclusively. It was concluded that the technique has possibilities, and improved equipment is being developed. (A.G.W.)

13028 CHERENKOV RADIATION FROM E.A.S. J. Malos, C. D. Millar, and O. S. Wallace (Univ. of Sydney). J. Phys. Soc. Japan, 17: Suppl. A-III, 114-17(Jan, 1962).

Exploratory experiments were made using narrow angle detectors of the atmospheric Cherenkov light emitted by E.A.S. whose size, core location, and direction of incidence were determined with a scintillator array. The results are consistent with a proposed interpretation which leads to the conclusions (i) that the angular distribution of the light is broad and is determined by the Coulomb scattering of the emitting electrons, (ii) that the Cherenkov light pulse received is to a first approximation proportional to the mean particle density integrated along the axis of the detector, and (iii) that for such a detector close to the shower axis the maximum contribution to the detected light pulse from most of the detected showers is generated below an altitude of one kilometer. (auth)

13029 PRIMARY COSMIC-RAY COMPONENT IN SUPERHIGH-ENERGY REGION. S. N. Vernov, G. B. Khristiansen, V. I. Atrashkevich, V. A. Dmitriev, Yu. Fomin, B. A. Khrenov, G. V. Kulikov, Yu. A. Nechin, and V. I. Soloviyeva (Lebedev Inst. of Physics, USSR and Univ. of Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 118-22 (Jan. 1962).

Data on the size of extensive air showers at sea level show a notable irregularity in the integral spectrum in the region of $N \sim 5 \times 10^5$. Results of calculations of shower-size spectra at sea level are compared with the data, and an explanation of the irregularity is offered in terms of changes in the energy spectrum and the composition of primary cosmic rays. Experimental data on μ-meson fluxes

in showers are compared with theoretical calculations. An upper limit for the mean free path of the primary particle is determined. (A.G.W.)

13030 THE POSSIBLE EXISTENCE OF PHOTON-INITIATED EAS. R. Firkowski (Nuclear Research Inst., Polish Academy of Science, Lodz, Poland), J. Gawin, A. Zawadzki, and R. Maze. J. Phys. Soc. Japan, 17: Suppl. A-III, 123-7(Jan. 1962).

Results for a period of 15 months obtained with the Lodz experiment indicate an anomalous frequency of EAS events giving the penetrating multiplicity zero as compared to the frequency of EAS giving small multiplicity. It is shown that the effect is well explained by a background of abnormal showers equal to 3/1000 of the total frequency. (auth)

13031 BOLIVIAN AIR SHOWER JOINT EXPERIMENT. K. Suga, I. Escobar, G. Clark, W. Hazen, A. Hendel, and K. Murakami (Universidad Mayor de San Andres, La Paz, Bolivia). J. Phys. Soc. Japan, 17: Suppl. A-III, 128-30 (Jan. 1962).

A joint air shower experiment is being set up and is near full operation at an altitude of 5,200 m in Bolivia. The principal objectives and a brief account of the equipment are given. (auth)

13032 OBSERVATION OF THE POINT SOURCE OF COSMIC RAYS. Y. Sekido, I. Kondo, T. Murayama, Y. Kamiya, S. Sagisaka, H. Ueno, S. Mori, H. Okuda, T. Makino, and S. Sakakibara (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 131-6(Jan. 1962).

Further observations on the cosmic-ray intensity from the point source in Orion made by G-M counter telescopes (No. 1 and No. 2) since 1959 are discussed in connection with the results reported at the Moscow Conference. In the last two years, the intensity of the point source looks slightly higher than in the period 1957-1958, but is not significantly positive and much lower than in the period 1954-1956. From this result, a hypothesis presented at the Moscow Conference is not likely, in which it was assumed that the intensity of the source was proportional to the luminosity of W-Orionis and was expected to be high in 1960. Since Feb. 1961, the observation by a large cosmic-ray telescope (Telescope No. 3) has been started. In this period, the intensity of cosmic rays in the direction of the point source was +0.63% ±0.27% by Telescope No. 3 and +3.0% ±2.1% by Telescope No. 2, respectively, compared with the mean intensity. (auth)

13033 INTENSITY DISTRIBUTION OF HIGH-ENERGY COSMIC RAYS ON THE CELESTIAL SPHERE. I. Kondo, T. Murayama, S. Mori, H. Okuda, S. Sakakibara, and Y. Sekido (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 137-9(Jan. 1962).

Using a newly built gas Čerenkov telescope, observations of the intensity distribution of high-energy ($>10^{11}$ eV) cosmic-ray primaries on the celestial sphere were made. The celestial sphere ($-44° < \delta < 74°$) was divided into many parts of about 10^{-3} steradian, and the cosmic-ray intensity in each part was measured with a statistical accuracy of ±6%. By comparing the results obtained by duplicate telescope tubes, the observed anisotropy was studied statistically. Apart from the scanning, observation with higher statistical accuracy has been made in several regions of the sky containing astronomical objects of special interest. (auth)

13034 A GAS CHERENKOV COSMIC-RAY TELESCOPE. Y. Sekido, I. Kondo, T. Murayama, S. Mori, H. Okuda, S. Sakakibara, T. Makino, and T. Honzawa (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 139-44(Jan. 1962).

A cosmic-ray telescope was built to detect high-energy cosmic-ray charged particles by observing gas Čerenkov radiation emitted by them in a closed vessel without aid of any other particle detectors. Individual μ-mesons ($E > 10^{10}$ ev) were detected with sufficiently high efficiency (~95%) and with narrow angular resolution ($7°\phi$) in a wide scope ($15°\phi$). The telescope was built on an alt-azimuth mounting (azimuthal angle $0° \sim 360°$, zenith distance $0° \sim 90°$), and has a large detection area (20 m^2), so it can be used to observe the intensity of cosmic rays coming from a nearly horizontal direction with appreciable accuracy. This telescope was planned and constructed for the study of the anisotropy of primary cosmic rays. It can be used also for the study of the time variation of cosmic-ray intensity and for any other experiments to detect high-speed charged particles of very low flux density. (auth)

13035 SIDEREAL TIME VARIATION OF LOW-ENERGY COSMIC RAYS. A. M. Conforto (Universita, Rome). J. Phys. Soc. Japan, 17: Suppl. A-III, 144-7(Jan. 1962).

Previously published papers on this subject are reviewed. Tables show figures obtained by various investigations for the sidereal times of maximum. The amplitude ratios of sidereal and solar variation are included. Most of the data were taken in 1954. (A.G.W.)

13036 ON THE MECHANISM OF STELLAR EXPLOSION. Y. Ono and S. Sakashita (Hokkaido Univ., Sapporo). J. Phys. Soc. Japan, 17: Suppl. A-III, 153-6(Jan. 1962).

A method of treating the propagation of shock waves in the stellar interior is described. The method consists of dividing the inhomogeneous layer into infinitesimal ones and applying the law of reflection and refraction of a shock wave to each infinitesimal layer. Application of the method to the mechanism of supernovae and the origin of planetary nebulae leads to the conclusion that the planetary nebulae seem to be originated from the loose stars at giant stages. (A.G.W.)

13037 THE DYNAMICS OF A SUPERNOVA EXPLOSION. Stirling A. Colgate, William H. Grasberger, and Richard H. White (Univ. of California, Livermore). J. Phys. Soc. Japan, 17: Suppl. A-III, 157-60(Jan. 1962).

The dynamical implosion of a supernova star 10 solar masses was calculated using an equation of state that includes thermal decomposition of iron to helium and helium to neutrons and protons. Starting from an initial equilibrium star of polytropic index 3, a mock quasistatic evolution evolves the star by $2\frac{1}{2}\%$ total change in energy until a dynamical collapse takes place. The validity of the calculation is limited to $\rho \leq 3 \times 10^{11}$ g/cm^3 corresponding to a compression of the central zones of 10^4 at which point the transformation to a neutron star by inverse beta decay occurs within the dynamic time of the implosion. The pressure at this time is one-half that required for mechanical support of the star so that further collapse to a neutron star is expected, provided the fractional energy in rotation or magnetic fields is small. The "bounce" of a neutron star due to adiabatic compression will occur at very much higher densities. We created a "bounce" artificially after 10^3 fold compression assuming that the initial rotational energy of the core was 10^{-3} of the internal energy. The bounce forms a shock wave which ejects approximately 1 solar mass with a specific energy (2×10^{18} erg/g) equal to its gravitational potential. This potential at the ejection mass cut depends in turn on the dynamical energy of the core implosion, but excluding the inverse beta decay, the shock strength heats the ejected mass to 4.0×10^9 degrees

and compresses it to 10^7 g/cm^3. The temperature and density time history of the subsequent expansion determines the nuclear composition of the ejected material and this is independent of the initial state because the fractional thermonuclear energy addition is small compared to the shock energy. The characteristic expansion time starts at 0.07 sec, increasing to 0.4 sec at 10^5 density while the temperature falls 1/3 as fast. (auth)

13038 THE ORIGIN OF ^{3}He ON THE SURFACES OF STARS AND IN PRIMARY COSMIC RADIATION. E. M. Burbidge and G. R. Burbidge (Univ. of Chicago). J. Phys. Soc. Japan, 17: Suppl. A-III, 161-4(Jan. 1962).

Investigations of the abundances of He^3, Li, Be, and B on the surfaces of stars and in primary cosmic radiation are reviewed. Three possible explanations of the results are considered: (1) There may be cosmic-ray sources in which the He^3 abundance is very high. (2) Cosmic rays may be ejected from the surfaces of magnetically active stars in which He^3 may be produced by surface nuclear activity. (3) If the cosmic-ray abundance of He^3 is found to vary with energy in such a way as to make it possible to explain both it and the Li, Be, and B abundances wholly by spallation of heavy primary particles in the interstellar medium, then the problem concerns the source of a high abundance of heavy particles. (A.G.W.)

13039 ENERGY SPECTRUM OF SUPRATHERMAL PARTICLES AND FORMATION OF STAR CLUSTERS IN INTERSTELLAR SPACE. Takeo Hatanaka, (Tokyo Univ.). Satio Hayakawa, Shiro Nishimura, Kazuo Takayanagi, and Wasaburo Unno. J. Phys. Soc. Japan, 17: Suppl. A-III, 165-8(Jan. 1962).

The energy spectrum of suprathermal particles in interstellar space is examined in connection with the temperature (~100°K) of normal interstellar HI clouds and with the formation of star clusters. The omnidirectional intensity spectrum $j_0(E)dE$ (E in kev) of suprathermal particles may be represented, for example, by $(2 \times 10^{-2}\ E)dE$ cm^{-2} sec^{-1} for $E < 10^3$ kev and $(2 \times 10^4/E)dE$ cm^{-2} sec^{-1} for $E > 10^3$ kev. Interstellar clouds with masses M less than 10^3 M are stable against contraction, while a proto-galactic-cluster with $M \sim 10^2$ M and radius $R \sim 10^{19}$ cm can be originated from a cold core of a cloud of $M \sim 10^3$ M owing to the gravitational instability, in agreement with observed astronomical evidences. (auth)

13040 ANISOTROPY OF HIGH-ENERGY COSMIC RAYS IN THE GALACTIC ARMS. S. Fukui, S. Hayakawa, H. Nishimura, and H. Obayashi (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 169-70(Jan. 1962).

Previous reports indicate that the arrival directions of typical air showers are distributed nonuniformly and that the primaries that initiate the showers are possibly heavy nuclei with energies as high as 10^{17} ev. An explanation for the existence of such high-energy heavy nuclei and their observed anisotropy is offered. It is assumed that there is a strong source lying in the galactic arm so that the earth is connected to the source by a magnetic line of force. The possibility that both the source and the earth lie in a common magnetic bottle is considered. (A.G.W.)

13041 PROPAGATION OF COSMIC RAYS IN GALACTIC ARM. M. Oda (Tokyo Univ.) and H. Hasegawa. J. Phys. Soc. Japan, 17: Suppl. A-III, 171-2(Jan. 1962).

The anisotropy of cosmic air showers, the polarization of starlight, and the supernova are discussed briefly with respect to the magnetic structure of the galaxy. (A.G.W.)

13042 THE GALACTIC RADIO SPECTRUM AND THE ENERGY SPECTRUM OF COSMIC RAY ELECTRONS. J. E. Baldwin (Cavendish Lab., Cambridge, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 173-4(Jan. 1962).

Measurements of radio emission from the galaxy were made. The results show a curved spectrum with a slope of -0.35 at low frequencies and a mean slope over the whole frequency range of -0.54. These values correspond to differential energy spectra of the electrons of $E^{-1.7}$ and $E^{-2.08}$. There was no observed difference in spectrum between the disc and the halo of the galaxy. (A.G.W.)

13043 INTERACTION OF NUCLEI AND PHOTONS OF HIGH ENERGIES WITH A THERMAL RADIATION IN THE UNIVERSE. N. M. Gerasimova, A. I. Nikishov, and I. L. Rosenthal. J. Phys. Soc. Japan, 17: Suppl. A-III, 175(Jan. 1962).

Because of the Doppler effect, photons emitted by stars can be so energetic as to cause disintegrations of the cosmic-ray nuclei of high energies. If it is assumed that heavy nuclei have the greatest energy in cosmic radiation, then the photoeffect can change a high-energy part of the cosmic radiation spectrum. The effect is small for nuclei of galactic origin since it is necessary for total nucleus crushing that at least several reactions (γ,n) or (γ,p) take place. It is expected that a flux of γ quanta coming from a distant source will be weakened in the energy region of $\sim 10^{12}$ ev by the process $\gamma + \gamma \rightarrow e^+ + e^-$. (A.G.W.)

13044 ON THE ORIGIN OF COSMIC RAYS. Satio Hayakawa (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 181-8(Jan. 1962).

Opinions of different investigators on the origin of cosmic rays are summarized. Papers containing information on the following subjects are reviewed: isotopic abundance of He in primary cosmic rays; electrons and galactic radio emission; heavy nuclei at high energies; supernova explosion; equipartition of energy into three modes (the turbulent motion, the magnetic field, and the cosmic rays); preferential acceleration of heavy nuclei; range of metagalactic cosmic rays; relation of cosmic rays to the galactic structure. (A.G.W.)

13045 INVESTIGATIONS OF THE STRUCTURE AND THE DEVELOPMENT OF EXTENSIVE AIR SHOWERS. H. Hasegawa (Gakushuin Univ., Tokyo), S. Naranan, T. Matano, I. Miura, M. Oda, S. Shibata, G. Tanahashi, and Y. Tanaka. J. Phys. Soc. Japan, 17: Suppl. A-III, 189-95(Jan. 1962).

The relation of attenuation length to energy partition among components of a cosmic shower is shown. Values consistent with each other were found for the quantities involved. Diagrams show the lateral structure of showers. Studies of shower cores suggest the superposition of an energetic core on the ordinary core in about 10% of the showers. The differential energy spectrum of nuclear active particles in showers of size 10^4 to 10^6 shows an apparent change of the exponent between 10^{12} and 10^{13} ev. (A.G.W.)

13046 PROPERTIES OF EAS. S. Bennett, J. Delvaille, K. Greisen, and F. Kendziorski (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Japan, 17: Suppl. A-III, 196-202 (Jan. 1962).

The rate of absorption of EAS as a function of size from $N = 10^4$ to $N = 2 \times 10^9$ particles has been evaluated from measurements of the barometric coefficient and the zenith angle dependence of the shower frequency, and from a direct measurement of the average particle absorption coefficient. For $10^4 < N < 3 \times 10^5$ the particle absorption length is nearly constant, increasing slowly from about 180 to 220 g/cm^2, and reflecting the dominant influence of

the nuclear cascade. For $10^7 < N < 10^{10}$ the absorption coefficient decreases more rapidly with shower size, in agreement with a pure electronic cascade model, and approaching zero at $N \simeq 10^{10}$. Temperature coefficients of the EAS have been measured and found to be inconstant. Results are also presented on the distribution of radius of curvature of the shower front. The average curvature at large distances from the axis corresponds to a radius of 2.8 km. A magnetic spectrometer has been applied to measure the muon spectrum as a function of distance from the shower axis. Graphs and equations are given for the muon density as a function of shower size, radius, and muon energy and for the muon spectrum integrated over the shower plane, as a function of N and E. The positive charge excess of muons of median energy 9 Bev in EAS has been measured and found to be practically zero. This result implies that production by the K mode is an order of magnitude less than by the pion mode, and that the normal muon charge excess is due entirely to proton excess in the primary cosmic rays. (auth)

13047 HIGH ENERGY NUCLEAR-ACTIVE PARTICLES AND THE EXTENSIVE AIR SHOWERS WHICH ACCOMPANY THEM. S. I. Nikolsky, E. A. Murzina, and V. I. Yakovlev (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 203-4(Jan. 1962).

The spectra of high-energy nuclear active particles and extensive air showers that accompany them were measured. Figures show the following: spectrum of ionization bursts initiated by high-energy particles in carbon; integral spectrum of showers accompanying nuclear active particles of energy $E \geq 3 \times 10^{12}$ ev and $E \geq 8.3 \times 10^{12}$ ev; results of calculations of spectra of showers accompanying nucleons of energy 3×10^{12} ev at the observation level; data on events not accompanied by extensive air showers. (A.G.W.)

13048 NUCLEAR-ACTIVE PARTICLES IN SHOWERS WITH DIFFERENT NUMBER OF PARTICLES. T. V. Danilova, E. V. Denisov, S. I. Nikolsky, and A. A. Pomansky (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 205-6(Jan. 1962).

Measurements of the number of nuclear active particles in extensive air showers with different numbers of particles were carried out at an altitude of 3333 m. Preliminary results of both experiments and calculations are tabulated for showers with $N \cong 10^4$ and $N \cong 10^5$. It is concluded that in collisions of particles with energy $10^{10}-10^{12}$ ev an average fraction of nucleons, antinucleons, and hyperons among all the secondary particles produced in elementary acts is greater than 10%. (A.G.W.)

13049 ENERGY COMPOSITION OF THE EXTENSIVE AIR SHOWER CORES. E. I. Tukish and S. I. Nikolsky (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 206-8(Jan. 1962).

A detector consisting of four trays of ionization chambers with lead and carbon between them was used to measure the energy of electron-photon and nuclear active components near the axis of air showers. Relations were determined between shower size and energy of the electron-photon component of the shower core, between shower size and energy of the nuclear active component of the shower core, and between energies of the electron-photon and nuclear active components. (A.G.W.)

13050 CORRELATION OF THE MULTIPLE PENETRATING PARTICLES WITH EXTENSIVE AIR SHOWERS. S. Higashi, T. Kitamura, Y. Mishima, S. Miyamoto, T. Oshio, H. Shibata, and Y. Watase (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 209-12(Jan. 1962).

An array of cloud chambers and scintillation counters was used to measure the distribution of multiple penetrating particles and μ mesons associated with extensive air showers. The results lead to the conclusion that multiple penetrating particles can be approximately interpreted as the μ-meson component having a density of $> 7/m^2$ contained in air showers. (A.G.W.)

13051 ON μ-MESON BEAMS IN THE COMPOSITION OF EXTENSIVE AIR SHOWERS. S. N. Vernov, Ly-Don-Khva, B. A. Khrenov, and G. B. Khristiansen (Moscow State Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 213-18(Jan. 1962).

An arrangement of 16 groups of counters was used to determine the distance between the points of impact on the detector of any two μ mesons falling on the detector in an air shower. The experimental distribution of distances in the central region of the shower and in the periphery is shown and compared with the theoretical distribution. Several events assumed to be narrow μ-meson beams were observed. Possible sources of these beams are considered. (A.G.W.)

13052 AN EXPERIMENT TO DETERMINE THE HEIGHTS OF ORIGIN OF Mu-MESONS IN EXTENSIVE AIR SHOWERS. J. F. de Beer (Univ. of Potchefstroom, South Africa). J. Phys. Soc. Japan, 17: Suppl. A-III, 219-20 (Jan. 1962).

An array of liquid scintillators and spark counter μ-meson detectors is being used to observe the heights of origin of μ mesons in air showers. The method of calibration of the scintillators is described. No results are given. (A.G.W.)

13053 ON THE ALTITUDE VARIATION OF EXTENSIVE AIR SHOWERS IN THE UPPER HALF OF THE ATMOSPHERE. T. Imai (Inst. of Physical and Chemical Research, Tokyo), K. Kamata, S. Kawasaki, K. Murakami, and N. Ogita. J. Phys. Soc. Japan, 17: Suppl. A-III, 221-4 (Jan. 1962).

The behavior of extensive air showers was investigated in the upper half of the atmosphere. The zenith angle distribution of air showers with particle density more than 20 m^{-2} was observed by a Fukui-Miyamoto discharge chamber at 8500 m above sea level. The observed result agrees with the altitude variation of shower intensity, and shows that the intensity maximum of vertical air showers is at the depth of 500–550 g cm^{-2} of air. The lateral distribution of shower particles was measured by scintillator arrays at 7000 m above sea level. The average behavior of lateral distribution of the shower of size around 10^5 at this altitude observed within the distance of 0.1 Moliere unit from the core is approximately given by $f(r) \sim r^{-n}$; r in Moliere unit with, on the average, $n \sim 1.3$, but n of each shower fluctuates between 1.0 and 1.5. The intensity variation with altitude of air shower was calculated, using the shower curve theoretically obtained by Ueda and Ogita, and compared with experiment. (auth)

13054 EXPERIMENTAL DATA ON DEVELOPMENT OF EXTENSIVE AIR SHOWERS IN UPPER ATMOSPHERE. R. A. Antonov, Yu. A. Smorodin, and Z. I. Tulinova (Lebedev Inst. of Physics, Moscow and Moscow State Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 225-9(Jan. 1962).

Air showers at altitudes of 4, 6, 9, and 12 km were investigated by means of counter hodoscopes and ionization chambers. The arrangement of the apparatus made it possible to select showers whose axes were close to vertical. Data on lateral distribution of particles, altitude

variations, angular distributions, and density spectra are given. The existence of "young" showers with narrow lateral distribution of particles at high altitudes was confirmed. (A.G.W.)

13055 ATMOSPHERIC EFFECTS OF EXTENSIVE AIR SHOWERS OF VARIOUS MEAN SIZES. D. D. Krasilnikov, N. N. Efimov, and M. A. Nifontov (Laboratory of Physical Problems, Yakutsk Branch of Siberian Academy of Sciences). J. Phys. Soc. Japan, 17: Suppl. A-III, 230-1(Jan. 1962).

The barometric and temperature effects of extensive air showers in the size range 10^4 to 10^6 particles at 100 m were determined. The method used for estimation of geometrical effects gave good agreement with the usual method and was more convenient. The measured barometric coefficients did not agree with the assumption of constancy of shower-particle absorption length. (A.G.W.)

13056 NUMBER SPECTRUM OF EXTENSIVE AIR SHOWERS AT SEA LEVEL. N. N. Efimov, D. D. Krasilnikov, M. A. Nifontov, and F. K. Shamsutdinova (Yakutsk Branch of Siberian Academy of Sciences). J. Phys. Soc. Japan, 17: Suppl. A-III, 232-3(Jan. 1962).

A G-M counter arrangement was used to observe extensive air showers of various mean sizes at sea level. It is concluded that the integral number spectrum for the vertical intensity of showers at sea level can be presented by $J_v(>N) = 7.50 \times 10^4 \times N^{-1.4}$ m^{-2} h^{-1} sterad^{-1} for $N < 2 \times 10^5$ and $J_v(>N) = 2.85 \times 10^6 \times N^{-1.7}$ m^2 h^{-1} sterad^{-1} for $2 \times 10^5 < N < 10^7$. (A.G.W.)

13057 ANGULAR DISTRIBUTION OF THE PENETRATING COMPONENT OF EXTENSIVE AIR SHOWERS AT THE DEPTH OF 200 m.w.e. E. L. Andronikashvili, M. F. Bibilashvili, G. L. Vardenga, T. V. Gvaladze, A. K. Javrishvili, R. E. Kazarov, R. V. Kuridze, and I. I. Khaldeiva (Inst. of Physics, Academy of Sciences, Georgian SSR). J. Phys. Soc. Japan, 17: Suppl. A-III, 237-8(Jan. 1962).

The angular distribution of penetrating shower particles was investigated by different methods. Disagreement between the angular distribution of the penetrating component and the shower axis was observed. Reasons for the disagreement are considered. The exponent in the law of angular distribution of penetrating particles in extensive air showers was found to be $8.6^{+2.2}_{-2.0}$ as determined over space angles and $7.5^{+1.0}_{-2.1}$ as determined over projection angles. (A.G.W.)

13058 THE STRUCTURE OF EXTENSIVE COSMIC-RAY AIR SHOWERS NEAR THE SHOWER AXIS. M. G. Thompson and R. M. Tennent (Univ. of Leeds, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 239-40(Jan. 1962).

Cosmic-ray air showers containing from 10^4 to 10^5 particles were detected by an array of 19 closely packed, circular scintillation counters at 100 m above sea level. In analysis of the data, the structure function was assumed to be of the form $f(r) = Kr^{-n}$. It was estimated that the mean value of $\underline{n}$ increased from 0.7 at $8 < r < 100$ cm to 1.0 at $100 < r < 200$ cm and 1.2 at $200 < r < 300$ cm. For showers whose axes crossed the array $\underline{n}$ ranged from 0.4 to 1.8 with the most probable value being 0.75. (A.G.W.)

13059 A STUDY ON EAS AT MT. NORIKURA. S. Miyake, K. Hinotani, I. Katsumata, T. Kaneko, and N. Ito (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 240-3(Jan. 1962).

Main results obtained at Mt. Norikura (2770 m a.s.l.) are as follows: (1) Fluctuation of the lateral density distribution function near the axis and in the distant range was studied, and their relation on the average was shown. (2) Absorption length of shower rates was about 100 g/cm^2 from 10^5 to 10^6 in size. The length changed from 125 to 94 g/cm^2 depending on the classification by lateral structure. Apparent attenuation length of shower size was 140, 170, and 200 g/cm^2 for 10^{-11}, 10^{-12}, and 10^{-13} cm^{-2} sec^{-1} str^{-1} in frequency, respectively. (3) Lateral distribution of the N-component of different energy range was obtained in the form of $\exp(-r/r_0)$ where r_0 is 20 m, 7 m, and 2 m for the energies 2×10^8, 10^{10}, and 10^{11} ev, respectively. The integral energy spectrum at various distances from the axis was also observed. From these data, the total integral energy spectrum was obtained as $E^{-1.3}$. (4) The relation of the total number of N-particles to the size of the shower was $N_N \propto N_e^{0.6}$ independent of the energy of N-particles. (5) The change of character of the core was found by means of an energy flow trigger system at the size of 10^5. (6) Density spectrum and its area effect were observed. (7) Core structure has been discussed from the cloud chamber pictures. (auth)

13060 EXTENSIVE AIR SHOWERS AT 4200 m. J. Hersil (Laboratorio de Fisica Cosmica, La Paz, Bolivia), I. Escobar, G. Clark, S. Olbert, C. Moore, and D. Scott. J. Phys. Soc. Japan, 17: Suppl. A-III, 243-6(Jan. 1962).

Extensive air showers were studied at an altitude of 4200 m with the same apparatus previously used at sea level. The properties of the showers were found to be distinctly different at the higher altitude. It is concluded that the average atmospheric depth of maximum development for showers with a maximum of 2×10^8 particles is about 800 g cm^{-2}. The average lateral distribution at distances greater than 30 m from the core is markedly steeper than at sea level and varies significantly with zenith angle. A map of the celestial arrival directions of 195 showers with $N > 10^8$ and 6 with $N > 10^9$, corresponding to primary energies in excess of 10^{17} and 10^{18} ev respectively, shows no anistropy. Because of the geographic location (near La Paz, Bolivia) most of the events came from the southern hemisphere. (A.G.W.)

13061 FLUCTUATIONS AND CORRELATIONS IN THE FLUCTUATIONS OF VARIOUS COMPONENTS OF EXTENSIVE AIR SHOWERS. B. K. Chatterjee, G. T. Murthy, S. Naranan, T. N. Ranga Swamy, B. V. Sreekantan, and M. V. Srinivasa Rao (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 247-50 (Jan. 1962).

An air-shower array designed specifically to study fluctuations of N particles and μ mesons was operated at an altitude of 800 g/cm^2. Figures show variation of lateral distribution and number of nuclear active particles and μ mesons with shower size. From data given on fluctuations of N particles and μ mesons, it is seen that N particles and μ mesons fluctuate together and the order of fluctuation is of comparable magnitude. (A.G.W.)

13062 ENERGY SPECTRUM OF NUCLEAR ACTIVE PARTICLES AS DETERMINED BY A TOTAL ABSORPTION SPECTROMETER AT 2.2 kms. R. Raghavan, B. V. Sreekantan, A. Subramanian, and S. D. Verma (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 251-4(Jan. 1962).

The experimental arrangement for determining the energy spectrum in the range 2×10^{11} to 10^{12} ev, the calibration of the spectrometer, the criteria for selection of nuclear active particles traversing the spectrometer, and errors involved are discussed. From the data obtained, the absolute flux value for nuclear active particles at 800 g/cm^2 for energies >450 Bev is $(1 - 2.3) \pm 0.1 \times 10^{-7}$ particles

cm^{-2} sec^{-1} $sterad^{-1}$. The integral energy spectra of all nuclear active particles observed and of those associated with air showers can be represented as power laws with negative exponents 1.45 ± 0.15 and 1.25 ± 0.15 respectively. (A.G.W.)

13063 THE EFFECT OF FINITE THICKNESS OF SCINTILLATORS ON THE DETERMINATION OF THE DENSITIES OF CHARGED PARTICLES IN AIR SHOWER EXPERIMENTS. B. K. Chatterjee, G. T. Murthy, S. Naranan, T. N. Ranga Swamy, B. V. Sreekantan, and M. V. Srinivasa Rao (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 254-6 (Jan. 1962).

A variable-level liquid scintillator was placed a meter away from one of the plastic scintillators in an air shower array. The level of the liquid was varied from 1 to 8 cm and about 1000 air showers were recorded for each thickness. The densities of charged particles as determined from the liquid scintillator were compared with the densities determined by the neighboring plastic scintillator. Preliminary results indicated that with increasing thickness of liquid the density values decrease. (A.G.W.)

13064 EXCESS NEGATIVE CHARGE OF ELECTRON-PHOTON SHOWER AND THE COHERENT RADIATION ORIGINATING FROM IT. RADIORECORDING OF SHOWERS UNDER THE GROUND AND ON THE MOON. G. A. Askaryan (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 257-9(Jan. 1962).

Electron excess in electron-photon showers connected with positron annihilation in flight and with the contribution of compton and delta electrons in the cascade is considered. It is shown that at the maximum of the cascade development this excess appears to equal 10% of the number of the particles in a cascade. The Cerenkov radiation from this moving excess charge of a shower in dense media is estimated. The possibility of recording and using this radio emission of showers produced in blocks of dense matter by high-energy particles from an accelerator or from the cosmos is shown. It is indicated that there exists the possibility of recording the radio emission from the showers of penetrating particles in underground layers in which radio waves can propagate and in the moon ground with equipment brought to the lunar surface. (auth)

13065 AN ANALYSIS OF EXTENSIVE AIR SHOWERS IN CONNECTION WITH THE PRIMARY ENERGY SPECTRUM AND THE HIGH-ENERGY NUCLEAR INTERACTIONS. H. Fukuda (Tokyo Inst. of Tech.), N. Ogita, A. Ueda, and S. Takagi. J. Phys. Soc. Japan, 17: Suppl. A-III, 259-63(Jan. 1962).

Two possible explanations of the previously observed change in slope in the size spectrum of extensive air showers are considered: (1) a change in slope of the energy spectrum of primary particles and (2) a change in character of nuclear interaction in the very high energy region. Calculations of size and energy spectra were made on the basis of each assumption. It is concluded that, as far as present day data are concerned, both assumptions can claim to be valid. The calculated lateral distribution of high-energy nuclear active particles in air showers is shown. (A.G.W.)

13066 OBSERVATION OF AIR-SHOWER CORES NEAR SEA LEVEL. J. Gaebler, M. La Pointe, and W. Hazen (Univ. of Michigan, Ann Arbor). J. Phys. Soc. Japan, 17: Suppl. A-III, 264-5(Jan. 1962).

An array of 27 ionization chambers has been used to observe the density distribution of particles near the axis of small air showers ($N = 10^5$). The results for the first ten events (near hits) can be described by Nishimura-Kamata distributions with age parameter, s, greater than one. A cloud chamber at the center of the array was used to measure the intensity of the mu-meson and of the nuclear-interacting components. The statistics of the first ten events permit only rough determinations of these intensities. (auth)

13067 STUDY OF CORE STRUCTURE OF SMALL-SIZE AIR SHOWER. S. Miyake, B. V. Sreekantan, P. V. Ramanamurthy, V. S. Narasimhan, S. D. Verma, G. T. Murthy, and B. K. Chatterjee (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 266-70(Jan. 1962).

The density spectrum and the energy spectrum have been observed at sea level and at mountain altitude (800 g cm^{-2}) with an AS tray. The exponent of the density spectrum was -1.53 ± 0.1 at 800 g cm^{-2} and -1.55 ± 0.1 at sea level. The exponent of the total energy flow spectrum was -1.7 ± 0.1 at both altitudes. The exponents of the energy flow spectra with AS coincidence both at sea level and at mountain altitude were found to continuously steepen with increasing energy flow, and the spectrum varied largely depending on the condition of AS coincidence. From these features, it was found that (1) there is a clear change in the character of the core at about 10^5 in size of EAS, and (2) the change comes from interaction character in the high energy region. The series of observations is continuing by means of a water spectrometer, and preliminary results are presented. (auth)

13068 CLOUD CHAMBER STUDY OF EXTENSIVE AIR SHOWERS NEAR THE SEA LEVEL. T. Kameda, Y. Toyoda, and T. Maeda (Kobe Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 270-4(Jan. 1962).

Data obtained during operation of a multiplate cloud chamber for a year and a half are reported. Tables and figures show the following: values of the exponent n, when the energy spectra in various bands of distance from the axis are assumed to be represented by a power law of the form E^{-n}; lateral distribution and energy spectra of high-energy electronic components; lateral distribution and energy spectra of high-energy nuclear active components; energy spectra of atmospheric cascade showers. (A.G.W.)

13069 THE STRUCTURE OF EXTENSIVE AIR SHOWERS AT THE SEA LEVEL. G. B. Khristiansen, I. F. Belyaeva, A. T. Abrosimov, V. I. Atrashkevich, V. A. Dmitriev, Yu. A. Nechin, B. A. Khrenov, G. V. Kulikov, and V. I. Soloviyeva (Moscow State Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 275-81(Jan. 1962).

A large and complex device, which included detectors for charged particles, μ mesons, and nuclear active particles and covered an area of 4 hectares, was used to study the structure of extensive air showers for three years. Fluctuations of various components of the showers and agreement of the experimental data obtained with theoretical predictions are discussed. (A.G.W.)

13070 FINE STRUCTURE OF THE CORE OF EXTENSIVE AIR SHOWERS. M. Oda and Y. Tanaka (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 282-5(Jan. 1962).

Fine structure of the core of extensive air showers (EAS) was studied with a device named the neon hodoscope. Considerable fluctuation of the structure was found within 3 m from the axis. In particular, those cores are noted whose lateral distribution is definitely steeper than $1/r$ as close as 10 cm to the axis. As the implication of these cores, it is inferred that the majority of the transferred energy may

be concentrated to one or a few γ rays (or π^0 mesons) in some high-energy interactions of the order of 10^{14} ev. Three remarkable multi-core events were observed. From the energy of the separate steep core and its distance from the main axis of the EAS, the transverse momentum is estimated to be more than 5 Bev/c in each case, assuming that the separate core is due to the nuclear interaction within a few km above sea level. Frequency comparison would suggest that the large transverse momentum might be related to unusual concentration of the transferred energy into one or a few γ rays. (auth)

13071 EXTENSIVE AIR SHOWERS AT THEIR MAXIMUM DEVELOPMENT. George W. Clark (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. A-III, 286-8(Jan. 1962).

When observations of extensive air showers can be made at a point near their maximum development, the experimentally observed quantities are more simply related to fundamental ideas and can provide sharper tests of theory. The quantities of fundamental interest and their relation to each other are discussed. Present experimental knowledge of the atmospheric depths at which $(\partial N/\partial x)_s = 0$ for various values of N is summarized. A plot is shown that indicates roughly the average position of maximum development versus the size at maximum development. (A.G.W.)

13072 DEVELOPMENT OF EAS IN THE ATMOSPHERE. S. Miyake (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 291-2(Jan. 1962).

Results obtained by groups studying development of air showers in India and Japan are summarized. A figure shows a possible image for the development of extensive air showers in the atmosphere. (A.G.W.)

13073 EXTENSIVE AIR SHOWER WORK IN AUSTRALIA. C. B. A. McCusker (Univ. of Sydney). J. Phys. Soc. Japan, 17: Suppl. A-III, 293-9(Jan. 1962).

The density spectrum of extensive air showers was determined by a method based on data from Wilson cloud chambers. For the region 50 to 500 particles/m^2 the slope was -2.6 ± 0.2. For the region 1100 to 5000 particles/m^2 the slope was -3.9 ± 0.5. A theory of air showers is proposed. Calculations based on the proposed theory are compared with experimental data obtained by different groups. The theory appears to be fairly successful but has some obvious defects. (A.G.W.)

13074 THE POLARIZATION OF COSMIC RAY MuMESONS. Hale V. Bradt and George W. Clark (Massachusetts Inst. of Tech., Cambridge). J. Phys. Soc. Japan, 17: Suppl. A-III, 300-4(Jan. 1962).

The polarization of cosmic-ray μ mesons coming to rest in a brass absorber was measured at sea level with 12, 700, and 3700 g/cm^2 of cover above the absorber. For the three thicknesses of cover values for the absolute polarization obtained were 0.21 ± 0.03, 0.21 ± 0.04, and 0.20 ± 0.02, respectively. On the basis of a theory that the measured polarization depends, in part, upon the proportion of K mesons among the parents of stopped muons, K/π production ratios were determined for primary interaction energies of 40 and 100 Bev. (A.G.W.)

13075 POLARIZATION OF COSMIC RAY MUONS. A. I. Alikhayan, T. L. Asatiani, V. M. Krishchyan, E. M. Matevosyan, and R. O. Sharkhatunyan (Inst. of Physics, Academy of Sciences, Armenian SSR). J. Phys. Soc. Japan, 17: Suppl. A-III, 304-6(Jan. 1962).

Measurements of the polarization of cosmic-ray muons stopping in a Cu absorber were made underground. The value of polarization obtained was 0.25 ± 0.03. (A.G.W.)

13076 THE POLARIZATION OF COSMIC RAY MUONS OF DIFFERENT ENERGIES. B. Dolgoshein, B. Luchkob, and V. Ushakob. J. Phys. Soc. Japan, 17: Suppl. A-III, 310-11(Jan. 1962).

The degree of polarization of cosmic-ray muons was determined by the asymmetry of μ-e decay when muons were stopped in a Cu absorber. Results for muon energies of 0.2, 0.3, 0.55, 1.05, 1.4, and 1.55 Bev are tabulated. Values range from 0.25 ± 0.045 at 0.2 Bev to 0.40 ± 0.05 at 1.55 Bev. (A.G.W.)

13077 THE SPECTRUM OF COSMIC RAY MUONS AND PROTONS NEAR SEA LEVEL. G. Brooke, P. J. Hayman, F. E. Taylor, and A. W. Wolfendale (Durham College, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 311-12(Jan. 1962).

The momentum spectra of muons and protons are shown. The pion production spectrum was derived from the muon spectrum. The exponent of the pion production spectrum was found to be 2.64 ± 0.05 between 4 and 100 Bev/c. Below 4 Bev/c the exponent fell, reaching 2.07 at 2 Bev/c, and at higher momenta it increased slightly. The attenuation length for the nucleonic component was found to vary smoothly with momentum from 130 ± 5 g/cm^2 at 3 Bev/c to 100 ± 10 g/cm^2 at 100 Bev/c. (A.G.W.)

13078 THE MOMENTUM SPECTRUM OF COSMIC RAY MUONS AT A ZENITH ANGLE OF 80°. F. Ashton and A. M. Wolfendale (Durham College, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 313-14(Jan. 1962).

Cosmic-ray muons were detected by an apparatus accepting particles with zenith angles between 81°48′ and 78°28′. The observed rates of events were converted into an approximate differential momentum spectrum and the points were plotted. In comparison with the vertical spectrum previously measured, the reduction in flux of low-energy muons at the large zenith angle is marked. Agreement with the calculated spectrum is good. (A.G.W.)

13079 DIRECTIONAL AND MOMENTUM DEPENDENCE OF THE POSITIVE EXCESS OF THE COSMIC-RAY MESONS. Y. Kamiya, S. Sagisaka, H. Ueno, S. Kato, and Y. Sekido (Nagoya Univ., Japan). J. Phys. Soc. Japan, 17: Suppl. A-III, 315-18(Jan. 1962).

A magnetic spectrometer using a solid iron electromagnet was constructed to observe the charge and momentum of μ mesons at large zenith distances, and at various azimuths, with the momentum range 5–100 Bev/c. From this observation, the azimuthal and momentum dependence of positive excess was obtained. The positive excess was small or negative at east direction and large at west especially in low energy. This difference was found to be in agreement with the result of calculations considering only π-μ processes. The positive excess at the production layer was obtained considering the trajectories of μ mesons in the atmosphere and was about 25% in this momentum range. (auth)

13080 INTENSITY OF μ-MESONS AT DEPTHS GREATER THAN 2000 MWE. S. Miyake, V. S. Narasimham, and P. V. Ramana Murthy (Tate Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 318-21(Jan. 1962).

An experiment is in progress in Kolar Gold Mines (India) to measure μ-meson intensities underground at great depths, and the results obtained so far at 816, 1812, 3410, and 4280 mwe are given. The depth intensity curve of μ mesons is converted to the integral energy spectrum of μ

mesons at sea level, and it is found that the energy spectrum can be expressed in the form $N(>E) \propto E^{-(2.9\pm0.33)}$ in the range 600 Bev < Eμ < 2600 Bev. From this, the production spectrum of pions is inferred and compared with the other cosmic ray data. (auth)

13081 HYPERON EFFECT IN THE HIGH-ENERGY μ-MESON SPECTRUM AT SEA LEVEL. P. Babu and Yash Pal (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 322-6(Jan. 1962).

Production ratios of strange particles in collisions of 25-Bev protons with light nuclei indicate that in 30% of the collisions the baryon carrying most of the energy may be a hyperon. The fraction of hyperons probably increases with energy in proportion to the multiplicity of the particles produced, till it reaches a saturation value of about 0.8 at 10^{13} ev. Among other effects, this will lead to the consequence that most of the π mesons above an energy of a few hundred Bev found in the atmosphere will result from hyperon decay rather than from the "pionization" process. In this paper, the sea level flux and energy spectrum of muons arising via the hyperon process have been calculated. Starting from the known flux and energy spectrum of primary cosmic rays, it is shown that above 10^{12} ev the flux and energy spectrum of muons agrees very well with the absolute flux and the spectrum measured directly in other experiments and as inferred from measurement of high energy γ-ray spectrum in the atmosphere. Below 10^{12} ev the hyperon contribution to the μ-meson flux decreases progressively, as expected, till, at about 100 Bev, it becomes nearly half of the total flux of μ mesons as measured by various investigators. (auth)

13082 THE MOMENTUM SPECTRUM OF MUONS UNDERGROUND. M. J. Campbell, D. L. Jauncey, H. S. Murdoch, H. D. Rathgeber, and K. W. Ogilvie (Univ. of Sydney). J. Phys. Soc. Japan, 17: Suppl. A-III, 326-9 (Jan. 1962).

A determination has been made of the absolute underground muon spectrum at a depth of 7.2 kg cm^{-2} in the range 250 Mev to 100 Bev. Good agreement is obtained with the spectrum calculated for this depth from the sea level spectrum by making reasonable assumptions about energy loss. (auth)

13083 ON THE ENERGY LOSS OF THE μ-MESONS IN THE GROUND. Seinosuke Ozaki (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 330-2(Jan. 1962).

The range-energy relation for μ mesons in the ground is derived from experimental data of other investigators on the energy spectrum of μ mesons at sea level and the intensity of cosmic rays as a function of depth underground. This result is compared with the theoretical range-energy relation calculated from the conventional formula for the energy loss due to the processes of ionization, bremsstrahlung, direct pair production, π-meson production, etc. From the range-energy relation in earth, the exponent of the pion production spectrum was found to change from 1.65 to 2.1 with pion energy from 10^{10} ev to a few times 10^{12} ev. (A.G.W.)

13084 VERY LARGE BURST DUE TO HIGH ENERGY MUONS. S. Higashi (Osaka City Univ.), T. Kitamura, Y. Watase, M. Oda, and Y. Tanaka. J. Phys. Soc. Japan, 17: Suppl. A-III, 332-4(Jan. 1962).

Large muon detectors at 20 mwe underground were used to study bursts due to high-energy muons. About 11,000 bursts with more than 100 ionizing particles initiated in rock were observed. Experimentally observed frequency distribution of bursts as a function of size was compared with the size distribution calculated from theory. Approximate agreement was obtained. (A.G.W.)

13085 LARGE BURSTS UNDER 10.5 cm OF LEAD IN IONIZATION. D. D. Krasilnikov (Yakutsk Branch of Siberian Academy of Sciences). J. Phys. Soc. Japan, 17: Suppl. A-III, 335-40(Jan. 1962).

The integral size spectrum of ionization bursts observed near sea level in high-pressure ionization chambers under 10.5 cm of Pb is shown. The spectrum is in power law form with the exponent 2.08 ± 0.08. The effects of altitude and barometer changes on burst frequencies are considered Implications of the results with regard to the generation of μ mesons are discussed. (A.G.W.)

13086 INVESTIGATION OF HIGH-ENERGY μ-MESONS AT THE DEPTH OF 40 m.w.e. S. N. Vernov, M. Ghulam Sadiq, V. A. Dmitriev, and G. B. Khristiansen (Univ. of Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 341(Jan. 1962).

Measurements were made of the spectrum of ionization bursts produced by μ mesons in ionization chambers under 15 cm of Pb. The spectrum obtained may be approximated by a power law with the exponent −1.7 ± 0.15. It is concluded that the spectrum observed is due to μ mesons with energy 4×10^{10} ev ≤ E_μ ≤ 4×10^{12} ev. (A.G.W.)

13087 NEUTRON PRODUCTION BY COSMIC RAY MUONS. M. A. Meyer (Durham Coll., Eng.), A. W. Wolfendale, E. B. Hughes, and P. L. Marsden. J. Phys. Soc. Japan, 17: Suppl. A-III, 342-3(Jan. 1962).

An arrangement consisting of three detecting arrays, two above and one below a large electromagnet, and a standard IGY pile was used to study production of neutrons by negative cosmic-ray muons in the momentum range 1–100 Bev/c. The product of cross section and average multiplicity for bands of momentum is shown. Good agreement was found between theory and experiment. (A.G.W.)

13088 ON HARD SHOWERS PRODUCED BY μ-MESONS. K. Daiyasu (Osaka Univ.), K. Kobayakawa, T. Murota, and T. Nakano. J. Phys. Soc. Japan, 17: Suppl. A-III, 344-7 (Jan. 1962).

It is shown that the total cross section of hard showers produced by a μ meson or an electron is limited up to two unknown functions by using Lorentz and Gauge invariances only. The character of the strong interactions is confined in these functions. From the viewpoint of this fact, some preliminary analyses have been done in order to investigate what property the strong interaction should have to explain the results of the Osaka experiments, especially the spectrum of the transferred energy from the μ meson and the spectrum of the square of the transferred four momentum. (auth)

13089 DIRECT ELECTRON PAIR PRODUCTION IN 0.15 cm LEAD PLATES BY HIGH ENERGY COSMIC RAY MUONS. P. H. Stoker, C. H. Bornman, and J. P. van der Merwe (Potchefstroom Univ. of C.H.E., South Africa). J. Phys. Soc. Japan, 17: Suppl. A-III, 348-9(Jan. 1962).

An equation of Murota for the pair production cross section was modified according to the assumption that the energy transferred to the pair is much less than the primary energy. The modified formula led to a cross section 2 to 3 times smaller than that given by Murota's formula. This result was compared with experimental data obtained with a multiplate cloud chamber exposed to cosmic ray muons with energy above 1700 Mev. There was overall agreement of experiment with theory, but the experimental spectrum seemed to be flattened with respect to the theoretical spectrum. (A.G.W.)

13090 SCATTERING OF COSMIC RAY MUONS WITH MOMENTA BETWEEN 300 AND 1000 Mev/c IN LEAD, TIN, AND IRON. M. A. Meyer, J. A. M. de Villiers, N. S. Wolmarans, J. W. Koen, and I. J. Lessing (Potchefstroom Univ. of C.H.E., South Africa). J. Phys. Soc. Japan, 17: Suppl. A-III, 350-2(Jan. 1962).

A counter hodoscope experiment on the scattering of cosmic-ray muons in lead, tin, and iron is described. The momentum region 0.3 to 1 Bev/c was divided into three ranges. Only three lead distributions are shown in this paper. It was observed that the scattering is in agreement with Cooper and Rainwater's theory. (auth)

13091 ON HIGH-ENERGY NEUTRINO PHYSICS IN COSMIC RAYS. V. A. Kuzmin, M. A. Markov, G. T. Zatsepin, and I. M. Zheleznykh (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 353-6 (Jan. 1962).

The importance of doing experiments with high-energy cosmic-ray neutrinos is discussed. An experimental arrangement for the experiments is suggested, and reactions of neutrinos and antineutrinos that might yield useful information are considered. Event frequencies to be expected are estimated. (A.G.W.)

13092 THE SOLUTION OF THE KINETIC EQUATION FOR μ-MESONS PASSING THROUGH THE GREAT DEPTHS OF SUBSTANCE. G. T. Zatsepin and E. D. Mikhalchi (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 356-7(Jan. 1962).

The solution of the kinetic equation for μ mesons passing through dense substance is discussed. Relations between parameters involved and values for constants are shown. (A.G.W.)

13093 REVIEW OF STUDIES ON THE MOMENTUM SPECTRUM OF MUONS. A. W. Wolfendale (Durham Coll., Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 358-61(Jan. 1962).

Recent work on cosmic-ray muon spectra and polarization is summarized. Figures included show the differential momentum spectrum of muons near sea level in the vertical direction, the differential pion production spectrum, comparison of the integral muon spectrum at sea level with that derived from γ-ray measurements, and variation with zenith angle of the integral rate of cosmic rays at sea level. (A.G.W.)

13094 HARD SHOWERS PRODUCED BY HIGH-ENERGY μ-MESONS. S. Higashi, T. Kitamura, Y. Mishima, S. Mitani, S. Miyamoto, T. Oshio, H. Shibata, K. Watanabe, and Y. Watase (Osaka City Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 362-6(Jan. 1962).

Two cloud chambers, one containing Pb plates and one containing Fe plates, were used for hard-shower observations at a depth of 50 M(we) from the top of the atmosphere. A table gives the ratio of the number of secondary showers to that of primary showers, mean multiplicities of secondary penetrating particles and heavily ionizing particles, and cross sections of nuclear interactions of μ mesons. The angular distribution of surviving μ mesons and of secondary particles other than μ mesons and the distribution of transferred energies are shown in figures. From these results, the features of hard showers produced by μ mesons seem to be better represented by the Williams-Weizsäcker expression than by Kessler's formula. (A.G.W.)

13095 COMMENTS ON STANDPOINT FOR ANALYSES OF HARD SHOWERS BY μ-MESONS. K. Daiyasu (Osaka Univ., Japan), K. Kobayakawa, T. Murota, and T. Nakano. J. Phys. Soc. Japan, 17: Suppl. A-III, 367-8(Jan. 1962).

The total cross section of hard showers produced by a muon-nucleon or an electron-nucleon collision is limited up to two unknown functions, L and L^1, by using only Lorentz and Gauge invariances. Theoretical analyses so far performed are based on special assumptions as to L and L^1, which are shown in a table. Present knowledge is insufficient to determine the validity of these assumptions. (A.G.W.)

13096 DEEP UNDERGROUND STUDIES OF MUON INTENSITIES AND INVESTIGATIONS ON THE INTERACTIONS OF MUONS. M. G. K. Menon (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 368-74(Jan. 1962).

The present status of knowledge concerning the intensities of μ mesons at various depths underground is reviewed. Available data are shown in figures. In a discussion of the situation concerning the interactions of μ mesons, work on the following is considered: hyperon effects in cosmic-ray phenomena; scattering of muons in Pb, Sn, and Fe; neutron production by fast muons. Experiments that could yield useful information in the field are suggested. (A.G.W.)

13097 EXPERIMENTAL DATA ON NUCLEON-NUCLEON INTERACTIONS AT THE ENERGY OF HUNDREDS OF Gev AND THEIR INTERACTION. V. V. Guseva, N. A. Dobrotin, N. G. Zelevinskaya, K. A. Kotelnikov, A. M. Lebedev, and S. A. Slavatinsky (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 375-83 (Jan. 1962).

The experimental arrangement used for studying nucleon-nucleon interactions included 2 cloud chambers and an "ionization calorimeter" consisting of 8 layers of ionization chambers separated by Pb and brass filters. A LiH target was placed between the chambers. Study of about 60 showers generated in the LiH target to date leads to the conclusion that the showers were produced in nucleon-nucleon collisions. The existence of asymmetrical showers in the C-system of colliding nucleons is confirmed. Values of the inelasticity coefficients for 46 showers are given. The characteristics of nucleon-nucleon interactions are considered in relation to the assumption that an excited meson cloud that does not include the colliding nucleons is formed. The data obtained seem to be consistent with this assumption. (A.G.W.)

13098 MOUNTAIN-ALTITUDE STUDIES OF THE INTERACTION OF HIGH-ENERGY PARTICLES WITH ATOMIC NUCLEI. H. P. Babayan, N. G. Bejadjan, Ya. S. Babecki, Z. A. Buja, N. L. Grigorov, J. Loskiewicz, J. Massalski, A. Oles, C. A. Tretyakova, and V. Ya. Schestoperov (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 383-6(Jan. 1962).

An arrangement consisting of 6 trays of ionization chambers situated under a combination filter of graphite and Pb was used to study large ionization bursts at 3200 m above sea level. The exponent of the spectrum of bursts due to single nuclear active particles was found to be 1.98 ± 0.09, and for the burst spectrum due to μ mesons the exponent was 2.22 ± 0.14. Results of a study of the form of the ionization-burst spectrum as a function of the dimensions of the recording apparatus are tabulated. The burst spectrum measured by separate chambers is compared with the energy spectrum of nuclear active particles measured by an ionization calorimeter. The character of energy transfer to π^0 mesons in the bursts is analyzed. (A.G.W.)

13099 CHARACTERISTICS OF HIGH ENERGY NUCLEAR INTERACTIONS. AN EXPERIMENTAL STUDY WITH THE COMBINED TECHNIQUES OF MULTIPLATE CLOUD CHAMBER, AIR CHERENKOV COUNTER AND TOTAL ABSORPTION SPECTROMETER. Siddheswar Lal, R. Raghavan, B. V. Sreekantan, A. Subrahranian, and S. D. Verma (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 390-2(Jan. 1962).

The characteristics of nuclear interactions induced by cosmic-ray particles ≥30 Bev are being studied. Results presented are based on an analysis of 30 interactions observed in the graphite layers inside the cloud chamber. In a majority of nucleon-nucleon collisions at energies ~50 Bev, there were no sharp asymmetries of angular distributions of secondaries in their center of mass. The average fast charged secondary multiplicity for cases of identified pion interactions was 4 ± 1 in the energy range 30–40 Bev. For the cases of other charged primary interactions in the same energy range, the mean charged multiplicity was 5.7 ± 0.6. The fractional energy radiated as pions was $3\Sigma E_{\pi^0}/E_0 = 13-17\%$. (A.G.W.)

13100 A STUDY OF NUCLEAR INTERACTIONS AT 20 TO 150 Gev IN CARBON. Siddheswar Lal, Yash Pal, and R. Raghavan (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 393-4(Jan. 1962).

A multiplate cloud chamber was used to study nuclear interactions produced in carbon at an altitude of 2.2 km. Results of analysis of 122 events are summarized as follows. The integral energy spectrum obtained may be expressed by a power law with a negative exponent $1.3^{+0.26}_{-0.25}$. The ratio of neutral to charged particles among the interacting particles of 20–150 Bev is 0.69 ± 0.13. The average multiplicity of charged shower particles is 5.6 ± 0.2 for events whose multiplicity is ≥3. The inelasticity for production of π mesons with a C target is $K_\pi = 0.24 \pm 0.04$ (c.m.s.). The average total energy of a π meson is 430 ± 50 Mev (c.m.s.). The angular distribution of created particles in the center-of-mass system is isotropic. The average value of the transverse momentum for neutral π mesons is 390 ± 25 Mev/c. The ratio of π^0 to charged shower particles among the created particles is 0.4 ± 0.04. The interaction mean free path in brass for charged secondary particles is 133 ± 14 gm/cm^2. (A.G.W.)

13101 INVESTIGATION OF A DEPENDENCE OF THE AVERAGE FRACTION OF ENERGY IMPARTED TO THE NEUTRAL PIONS ON THE PRIMARY ENERGY. S. A. Azimov, A. M. Abdullaev, V. M. Mjalkovskij, and T. S. Juldašbaev (Inst. of Physics and Tech., Academy of Sciences, Uzbek SSR). J. Phys. Soc. Japan, 17: Suppl. A-III, 394-5(Jan. 1962).

A system of Cherenkov counters was used in experiments at 3200 m above sea level. In 850 hr running time, 550 showers created in a carbon block by single particles of energy >50 Bev were registered. Analysis of the data led to the following conclusions: (1) The fraction of the primary energy transferred to the secondary π mesons in nucleon-nucleon interactions with energies 70–700 Bev is <50%. (2) The coefficient of inelasticity K_{π^0} depends slightly on the primary energy. (3) Multiplicity of the secondaries increases slowly with increasing primary energy. (A.G.W.)

13102 THE COMPOSITION OF THE FLUX OF THE COSMIC RAY NUCLEAR-ACTIVE PARTICLES OF MOMENTA HIGHER THAN 1.8 Bev/c AT THE ALTITUDE OF 3250 m ABOVE SEA LEVEL. A. V. Khrimian, V. V. Avakian, N. A. Nalbandian, K. Sh. Egian, and M. P. Pleshko (Inst. of Physics, Academy of Sciences, Armenian SSR). J. Phys. Soc. Japan, 17: Suppl. A-III, 395-8(Jan. 1962).

The nature and the momentum spectra of the nuclear active particles of cosmic radiation are investigated by means of a magnetic mass spectrometer and five-layer gas proportional counters at the altitude of 3250 m above sea level. The results of the measurement of momenta and the ionization of the particles are given for the interval of momenta 0.1–20 Bev/c. In the flux of the nuclear active particles of the cosmic radiation in the air it is found that the ratio $N_{\pi^+}/N_{\pi^-} = 0.90 \pm 0.15$ in the interval of momenta 100–720 Mev/c; π mesons are ~5% of all the particles in the interval of momenta 0.1–22 Bev/c and not more than 10% of the particles of momenta ≥1.8 Bev/c. (auth)

13103 INTERNATIONAL COOPERATIVE EMULSION FLIGHT. J. Phys. Soc. Japan, 17: Suppl. A-III, 399-402 (Jan. 1962).

Results obtained so far by the ICEF collaboration project on high-energy nuclear interactions are reported briefly. Histograms of the observed transverse momentum of the secondary particles are shown. Estimation of the primary energy of a high-energy cascade and the partition of the energy between the charged secondary and the secondary π^0 are considered. About one-third of the events analyzed shows evidence of asymmetric emission of particles in the elementary act. (A.G.W.)

13104 A COMPARISON OF PION AND NUCLEAR INTERACTIONS IN EMULSION AT ENERGIES BETWEEN 10^{11} AND 10^{13} ev. F. A. Brisbout, C. Gauld, C. B. A. McCusker, J. Malos, K. Nishikawa, L. S. Peak, and L. G. van Loon (Univ. of Sydney). J. Phys. Soc. Japan, 17: Suppl. A-III, 403-4(Jan. 1962).

Data from a 10-liter stack of pure emulsion flown to 126,000 ft over Texas, combined with previously published results of other groups, lead to the following conclusions: The interaction mean free path of jet secondaries is $37.7^{+1.1}_{-1.1}$ cm which corresponds to a cross section per nucleon of ~20 mb. The average number of shower particles in secondary jets is 12.3 ± 0.3. The average number of shower particles in primary jets produced by minimum ionizing particles is 22.5 ± 0.4. For secondary jets the average number of heavy prongs decreases with increasing energy. (A.G.W.)

13105 HIGH ENERGY NUCLEAR INTERACTION WITH ISOTROPIC DISTRIBUTION OF GENERATED PARTICLES. K. I. Alekseeva, L. L. Gabunia, G. B. Zhdanov, Jen Phyong Soo, and M. I. Tretyakova (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 409-11(Jan. 1962).

While scanning one liter of photoemulsions exposed for ~150 hr at ~10 km altitude, an interesting event of the type 2 + 3 + 40 p was found. The angular distribution of particles is shown and compared with calculated curves for an isotropic distribution of particles. Good agreement is obtained. Possible explanations of the reaction are considered. (A.G.W.)

13106 SHOWERS FORMED BY NUCLEI WITH ENERGY OF ≥ 5.10^{10} ev/NUCLEON. A. A. Loctionov and J. S. Takibaev (Academy of Sciences, Kazakh SSR). J. Phys. Soc. Japan, 17: Suppl. A-III, 412-19(Jan. 1962).

The types of primary-particle interactions with emulsion nuclei and the dependence of multiplicity, angular distribution, and inelasticity upon energy have been investigated for showers formed by nuclei ($z \geq 2$). The results of the present analysis have been compared with the well-known data on nucleon-nucleon showers. (auth)

13107 SOME PROBLEMS OF GENERATION OF STRANGE PARTICLES. Z. Sh. Manjavidze and N. H. Roinishvili (Academy of Sciences, Georgian SSR). J. Phys. Soc. Japan, 17: Suppl. A-III, 420-2(Jan. 1962).

Results based on $49\Lambda^0$, $42\Theta^0$, and $18\Sigma^{\pm}$ particles registered in penetrating cosmic showers at an altitude of 1800 m are given. The energy spectra of the $\Sigma^{\pm}$ and Λ^0 particles were found to be quite similar, whereas the spectrum of Θ^0 particles resembled that of π mesons generated under the same conditions. Within statistical probabilities the transverse momentum spectra of Λ^0, $\Sigma^{\pm}$, and Θ^0 particles did not differ and repeated in general features the transverse momentum distributions of π mesons. The transverse momentum distribution of neither strange particles nor mesons was found to be sensitive to change in energy of the generating particle in the range 10–100 Bev. The possible theoretical interpretation of the results is considered briefly. (A.G.W.)

13108 SOME FEATURES OF NUCLEAR INTERACTIONS OF ENERGY BETWEEN 10^{12} AND 10^{15} ev. M. G. Bowler, J. G. Duthie, P. H. Fowler, A. Kaddoura, and D. H. Perkins (Univ. of Bristol, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 423(Jan. 1962).

The energy spectrum of electromagnetic cascades produced by nuclear active particles was determined from emulsion stacks flown at altitudes of 220 g/cm^2 and 8 to 28 g/cm^2. The results do not confirm the change in exponent of the nuclear spectrum previously reported at $1500 < E < 4000$ Bev. The interaction mean free path of nuclear particles producing cascades in the energy range 400 to 1500 Bev was found to be 39 ± 12 cm in G-5 emulsion. (A.G.W.)

13109 HIGH ENERGY GAMMA RAYS AND JET SHOWERS. M. Bowler, J. Duthie, P. Fowler, A. Kaddoura, D. Perkins, K. Pinkau, and W. Wolter (Univ. of Bristol, Eng.). J. Phys. Soc. Japan, 17: Suppl. A-III, 424-6(Jan. 1962).

Four stacks of emulsion and heavy material were flown at about 220 g/cm^2, and 3 stacks of similar composition were flown on balloons at altitudes ranging from 8 to 28 g/cm^2. Integral energy spectra of both nuclear events and γ rays at each altitude are shown. The expected muon energy spectrum calculated from the rate of production of γ rays is compared with measurements of the muon spectrum; no discrepancy appears. (A.G.W.)

13110 PRODUCTION OF THE ELECTRON-PHOTON COMPONENT IN THE INTERACTION OF PARTICLES OF ENERGIES 10^{12} TO 10^{14} ev WITH LIGHT NUCLEI IN ATMOSPHERE. L. T. Baradzei, V. I. Rubtsov, Y. A. Smorodin, M. V. Solovyov, and B. V. Tolkachev (Lebedev Inst. of Physics, Moscow and Univ. of Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 433-9(Jan. 1962).

Ionization chambers were used to study the spectrum of γ quanta in the atmosphere. The energy of cascades was determined from the value of the ionization burst under a filter whose thickness was chosen in such a way that the cascade was near maximum development. From data recorded on the energy spectra of electron-photon cascades incident on the apparatus from the air at pressures 200, 300, and 1030 g/cm^2, the spectra of photon production in the atmosphere were calculated. Spectra of nuclear active particles at pressures 200 and 300 g/cm^2 are also shown. The ionization chamber data obtained are compared with results obtained by photographic emulsions. Agreement is reasonably good except for the case of photon spectra at energies above $(2-4) \times 10^{12}$ ev. Reasons for this difference are discussed. Data on the paths for absorption of nuclear active particles in the atmosphere are tabulated. A summary of experimental data on the nucleon component in the atmosphere leads to the conclusion that the inelasticity coefficient of interaction does not change considerably in a very extensive energy range. (A.G.W.)

13111 OBSERVATIONS ON THE PROBABLE CORE OF AN EXTENSIVE AIR SHOWER RECORDED IN AN EMULSION STACK. S. N. Ganguli, N. Kameswara Rao, and M. S. Swami (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Japan, 17: Suppl. A-III, 439-43 (Jan. 1962).

A detailed study of a shower, consisting of a family of 87 electromagnetic cascades, recorded in an emulsion block, is presented here. The cascades attributed to individual γ rays or electrons incident on the stack were recorded during the transit of the stack from Berkeley to Bombay, probably at an altitude of 6 kilometers. The cascade energies were measured. The cascade density as a function of radial distance (R) from the shower axis is found to be proportional to $R^{-1.5}$ and the energy flux to $R^{-2.4}$. The integral energy spectrum is of the form $N(>E) \propto E^{-2}$ for values of $E > 10^{11}$ ev. It is shown that it is extremely unlikely that the event is due to a nuclear interaction in the immediate neighborhood of the stack; it is therefore attributed to the core of an EAS. (auth)

13112 RESULTS ON THE ANGULAR AND RADIAL DISTRIBUTIONS OF PARTICLES IN ELECTRON-PHOTON SHOWERS. H. Messel, D. F. Crawford, A. D. Smirnov, A. A. Varfolomeev, and J. C. Butcher (Univ. of Sydney). J. Phys. Soc. Japan, 17: Suppl. A-III, 444-5(Jan. 1962).

Calculations are being completed for electron and photon radial and angular distribution functions in lead and in emulsion absorbers. Electron primaries of energy 50, 100, 200, 500, and 1000 Mev and photon and electron secondaries of energy 10, 20, 50, 100, 200, and 500 Mev have been considered. The complete results are to be given in a set of 776 Tables. The Monte Carlo calculations performed using the electronic computer, SILLIAC, took into account multiple scattering, collision losses, and Compton effect; Bethe-Heitler cross-sections accurate at low and high energies were used. (auth)

13113 THE THREE-DIMENSIONAL DEVELOPMENT OF NUCLEONIC CASCADES. K. Pinkau (Institut für Reine und Angewandte Kernphysik, Kiel). J. Phys. Soc. Japan, 17: Suppl. A-III, 446-50(Jan. 1962).

Mathematical expressions for the longitudinal and lateral development of mucleonic cascades are derived. The functions of $(r^2)_{av}$ and $(\theta^2)_{av}$ obtained show a dependence upon E_0/E and y as expected (E_0 is the energy of the incident primary particle, r is the distance from the core, and θ the space angle of the particles at distance y along the axis). The angular (and lateral) distribution is noteworthy for its flatness in the center. It is concluded that a method similar to that previously derived for electromagnetic cascades should exist for the energy determination of nucleonic cascades (A.G.W.)

13114 ON A NON-LOCAL THEORY OF HIGH-ENERGY INTERACTIONS. G. Wataghin (Universita, Turin). J. Phys. Soc. Japan, 17: Suppl. A-III, 467-70(Jan. 1962).

Some experimental data on high-energy collisions are interpreted on the basis of a previously formulated nonlocal theory. The following observations are considered: (1) The average transverse momentum of particles produced in collision is limited by the relation $(p_\perp)_{CM} \leq \frac{1}{2} M$, where M is the proton mass and CM indicates the center

of momentum frame of the incident particles. (2) The average longitudinal momentum of created particles is limited by the relation $(p_{\parallel})_{CM} \leq M$. (3) The dominant feature of many high-energy collisions is the low value of the momentum transfer. (A.G.W.)

13115 HIGH ENERGY INTERACTIONS OF THE 'MOLECULAR MODEL' OF THE ELEMENTARY PARTICLES. Seitaro Nakamura (Tokyo Univ. and Nihon Univ., Tokyo). J. Phys. Soc. Japan, 17: Suppl. A-III, 470-4(Jan. 1962).

A model of the structure of elementary particles is suggested. A basic premise of the model is a variant scheme of the internal degrees of freedom for baryons in which strangeness and hypercharge are not used. In order to classify baryons, three kinds of "charge spins," τ, ζ, and K, are introduced, and it is assumed that the third component of these spins is simultaneously quantized. The mass spectra of nucleon isobars, pion isobars, hyperon isobars, and kaon isobars in the lowest state are discussed in relation to the suggested model. (A.G.W.)

13116 NOTE ON THE TWO-CENTRE OF JETS. K. O. Thielheim (Universitaet, Kiel). J. Phys. Soc. Japan, 17: Suppl. A-III, 474-6(Jan. 1962).

It is shown that some properties of inelastic nucleon-nucleon collisions in the high-energy region may be described quite well by a simple geometrical model on the basis of the two-center conception, which in contrast to other workers assumes that angular momentum is conserved as orbital angular momentum. As in geometrical optics it is assumed that rays may be constructed according to the same laws that would be obeyed by particles in classical relativistic mechanics. To each ray a value $\underline{b}$ of impact parameter is attributed and predictions on the statistical distribution of observable quantities are derived from the equidistribution of $\underline{b}^2$. This is a phenomenological model as no assumptions are made on the nature of what is called centers or excited nucleons. (A.G.W.)

13117 A MODEL FOR MULTIPLE MESON PRODUCTION IN NUCLEON-NUCLEON COLLISIONS. K. Niu (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 477-81(Jan. 1962).

A previously proposed model of multiple meson production in nucleon-nucleon collisions, in which a physical quantity called "momentum of interaction" was introduced as an essential parameter of a collision, is extended to asymmetric nucleon-nucleon collisions. Some examples of the angular distribution of mesons in asymmetric showers calculated by use of the extended model are shown. (A.G.W.)

13118 STATISTICAL ANALYSIS OF HIGH-ENERGY JET PHENOMENA. H. Shimoida and T. Yoneyama (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 482-7(Jan. 1962).

A previously proposed model of high-energy nucleon-nucleon collisions predicts that the angular distribution of the emitted particles from high-energy jets should show a characteristic shape, that is, the probability density function $f(x) = dN/dx$ should have two symmetrical maxima. In this analysis it is assumed that there exist two types of jets; the probability density function is divided into two parts, a two-fire-ball-like part and a "Rest" part. (A.G.W.)

13119 A SEMI-PHENOMENOLOGICAL APPROACH TO MULTIPLE MESON PRODUCTION. K. Daiyasu (Osaka Univ.), K. Kobayakawa, N. Yajima, H. Yokomi, T. Kobayashi, K. Mori, and T. Yomeyama. J. Phys. Soc. Japan, 17: Suppl. A-III, 488-92(Jan. 1962).

A theoretical approach to the fire-ball model is made. Taking account of the strong interaction among emitted pions in high-energy jets and the process of fire-ball disintegration one may consider the fire ball as an unstable boson with spin 0 or 1. Two (or one) or more fire balls would be produced in a peripheral nucleon-nucleon (or pion-nucleon) collision since the momentum transfer between two colliding particles is very small. Various quantities with respect to the production process of the fire balls are calculated field-theoretically in some simple cases based on the above points of view. The numerical results are not inconsistent with experimental data. (A.G.W.)

13120 ON THE CHARACTER OF COLLISIONS OF HIGH ENERGY NUCLEONS. G. T. Zatsepin (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 495-8(Jan. 1962).

Characteristic features of nuclear collisions at high energies are summarized. One fundamental result of investigation of nuclear collisions is the confirmation of multiple meson production. The process can be divided into two stages: (1) the stage of collision during which excited systems are produced and (2) the decay of the excited systems with emission of mesons and other particles. It is concluded that, in collision, nucleons behave like heavy point particles surrounded by π-meson fields weakly bound to them. There is evidence that at moderate energies of colliding nucleons one excited center is produced, whereas two excited centers are produced at higher energies. In both cases the evolution and decay of the excited center can be described by Heisenberg-type hydrodynamics. (A.G.W.)

13121 ON INTERACTIONS OF π-MESONS AND NUCLEONS AT HIGH ENERGIES. ("TARGET MASS" IN ONE-MESON-EXCHANGE INTERACTION). N. G. Birger and Yu. A. Smorodin (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 499-501(Jan. 1962).

In considering the inelastic interactions of high-energy particles the value M_t was introduced to represent the mass of the part of the target particle which participates in the interaction. A maximum was noted at the values of M_t close to pion mass μ in the experimentally observed M_t distribution for both N-N and π-N interactions at different energies. The possibility that this maximum may be connected with the peripheral one-meson interaction is considered. Agreement between experiment and the one-meson exchange model was not obtained without special assumptions. (A.G.W.)

13122 MANY-BODY THEORETICAL APPROACH TO THE FIRE-BALL MODEL IN MULTIPLE PRODUCTION OF PARTICLES. O. Kamei (Ochanomizu Univ., Tokyo), T. Kobayashi, and M. Namiki. J. Phys. Soc. Japan, 17: Suppl. A-III, 503-6(Jan. 1962).

The fire ball observed in multiple production of particles is interpreted and analyzed as a correlated assembly of produced particles like superfluid. It is shown that the momentum spectrum of produced mesons has a form dk/k^2 assuming $\lambda\phi^4$ for the final meson-meson interaction Hamiltonian. A possibility of the many-fire-ball model is discussed briefly. A possible reduction of the S-matrix element or the cross section of the overall process is presented, in which its final interaction part may be separated from the part of high-energy interaction in short collision time. (auth)

13123 A NEW MODEL FOR HIGH-ENERGY NUCLEAR INTERACTION. S. Hesegawa (Tokyo Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 507-11(Jan. 1962).

The hypothesis in which explosive production of mesons takes place through emission of a small number of the new quantum H is considered. The quantum H is supposed to convert into several mesons after the collision. Examples of emission of quantum H are shown in data on jet showers from various laboratories. General properties of the new quantum H are summarized. (A.G.W.)

13124 INTERACTION OF HIGH ENERGY NUCLEONS ACCORDING TO DIAGRAM METHOD VIEW POINT AND DOUBLE DISPERSION RELATIONS. D. S. Chernavsky, I. M. Dremin, and I. I. Roizen (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 512-14 (Jan. 1962).

Two questions are discussed: (1) What information on the behavior of $\sigma(s,k^2)$ and $D(k^2)$—unknown spectral functions appearing in the one-meson approximation (o.m.a.)—may be found on the basis of o.m.a. and of experimental data on N-N and π-N interactions at high energies? (2) To what extent is interference between an amplitude of o.m.a. and amplitudes corresponding to other diagrams essential? (A.G.W.)

13125 APPLICATION OF DIAGRAM METHOD TO THE CALCULATION OF CHARACTERISTICS FOR NUCLEON-NUCLEON INTERACTION AT THE ENERGY OF 300 Bev AND THEIR COMPARISON WITH EXPERIMENTAL DATA. D. S. Chernavsky, I. M. Dremin, V. M. Maximenko, and S. A. Slavatinsky (Lebedev Inst. of Physics, Moscow). J. Phys. Soc. Japan, 17: Suppl. A-III, 515-18(Jan. 1962).

The following characteristics of nucleon-nucleon interactions at 300 Bev were calculated by the diagram method: total N-N cross sections, multiplicity distribution of charged particles, angular distribution of secondary particles in the center-of-mass system, and inelasticity coefficient distribution. Comparison of the results with experimental data leads to the conclusion that the one-meson approximation can explain the main characteristic properties of N-N interaction at 300 Bev. (A.G.W.)

13126 REVIEW OF HIGH-ENERGY THEORIES. S. Takagi (Kyoto Univ.). J. Phys. Soc. Japan, 17: Suppl. A-III, 518-22(Jan. 1962).

The theory of elementary interactions, namely, multiple particle creation in nucleon-nucleon or pion-nucleon collisions is reviewed. The one-boson-exchange model and the fire-ball model are discussed. An unusual jet observed by the Norikura emulsion group, the role of hyperons in cosmic ray phenomena, and Hasegawa's theory based on the existence of a new quantum are considered briefly. (A.G.W.)

13127 THE ROLE OF HYPERONS IN EXTENSIVE AIR SHOWERS AND OTHER HIGH ENERGY COSMIC RAY PHENOMENA. B. Peters (Univ. of Copenhagen). J. Phys. Soc. Japan, 17: Suppl. A-III, 522-6(Jan. 1962).

Accelerator experiments on interactions produced by 25-Bev protons prove that between 0.2 and 0.6 hyperons must be produced per collision. From considerations of symmetry it follows that the particle which carries the largest fraction of the available energy away from the interaction is in 10–30% of the cases a hyperon rather than a nucleon. Information obtained from the study of high-energy cosmic-ray jets suggests strongly that the fraction of these hyperons increases further with energy, and that it probably amounts to 70% at a primary energy of 10^4 Bev. When the emerging hyperon decays, the decay pion receives a fraction of the hyperon energy which averages 16% for Λ and 20% for Σ hyperons. From arguments presented, it is concluded that practically all γ rays and charged π and μ mesons of 10^3 Bev or more found in the atmosphere are produced by the hyperon process. The relations between this result and the energy spectrum of γ rays, the charge excess of cosmic ray particles, and μ mesons observed underground are discussed. (A.G.W.)

13128 ANALYSIS OF TWO INFRARED BANDS OF CH_2D_2. Wm. Bruce Olson, Harry C. Allen, Jr., and Earle K. Plyler. J. Res. Natl. Bur. Std., A, 67: 27-30(Jan.-Feb. 1963).

Two infrared absorption bands of CH_2D_2 were analyzed in the semirigid rotor approximation. These are the A-type band at 2671.67 cm^{-1} and the C-type band at 4425.61 cm^{-1}. The A-type band has previously been assigned as $\nu_3 + \nu_9$, and the C-type band is tentatively assigned as $\nu_3 + \nu_6$. The upper state of the A-type band is perturbed presumably by the close lying level $2\nu_5$. The following values were found for the rotational constants of the ground vibrational state: $A_0 = 4.303\ cm^{-1}$, $B_0 = 3.504\ cm^{-1}$, $C_0 = 3.049\ cm^{-1}$. (auth)

13129 RELATION BETWEEN FOURIER TRANSFORM AND INTEGRAL REPRESENTATION FOR THE TWO AND THREE POINT FUNCTIONS. Bengt E. Y. Svensson (Univ. of Lund, Sweden). Nucl. Phys., 39: 198-219(Dec. 1962). (In English)

The relation between the Fourier transform and the discontinuity across the cut for the two-point function is studied in some detail without invoking local commutativity. The same method is then applied to the three-point function again without local commutativity. It is found that the discontinuity of the three-point function across the distinguished boundary of the analyticity domain is related to the Fourier transform by a "generalized Hankel transform" very similar to the corresponding two-point function relation. The method used is formal throughout, i.e., no conditions for convergence or justification of inverting orders of integration are given. (auth)

13130 CHARGE EXCHANGE IN NOBLE GASES. A. Galli, A. Giardini-Guidoni, and G. G. Volpi (Comitato Nazionale per l'Energia Nucleare, Rome and Università, Rome). Nuovo Cimento (10), 26: 845-54(Dec. 1, 1962). (In English)

The quantitative applicability of a proposed technique is tested by measurements of symmetrical charge-exchange cross sections for processes involving singly ionized ions of rare gases. The results are in agreement with those employing different techniques. The method is applied to measurements of cross sections of some asymmetrical processes, and of symmetrical ones involving doubly ionized ions. (auth)

13131 ASYMPTOTIC CONVERGENCE OF RENORMALIZED PERTURBATIVE EXPANSIONS. E. R. Caianiello (Università, Naples). Nuovo Cimento (10), 26: 998-1002 (Dec. 1, 1962). (In English)

It is proved that the renormalized perturbative expansions of propagation kernels in configuration space, for finite space-time volume of integration, are asymptotically convergent in the sense of Poincaré, if it is assumed that the kernels themselves are continuous functions of the expansion parameter in a neighborhood of the value of the parameter for which the expansions are made. (auth)

13132 ON THE LOWERING OF THE λ-POINT OF LIQUID HELIUM IN THIN FILMS AND NARROW CHANNELS. S. Franchetti and A. Mazza (Università, Florence). Nuovo Cimento (10), 26: 1010-16(Dec. 1, 1962).

The thickness of the unsaturated film and the density

distribution in it are studied. While the density distribution resembles that of the inner portion of the saturated film, the thickness turns out to be much smaller. Some reasons are given for the existence of a thermally sensitive transition layer in the inmost portion of the liquid. The atoms belonging to this layer share in the λ-condensation process, but do not become superfluid. It is shown that this behavior can account for the lowering of the λ point observed in unsaturated films, as well as in the flow through porous glass. (auth)

13133 A NOTE ON THE SECOND RANDOM-PHASE APPROXIMATION FOR THE SUPERCONDUCTING STATE. [PART] I. G. Fano and J. Sawicki (Università, Bologna). Nuovo Cimento (10), 26: 1097-1103(Dec. 1, 1962). (In English)

The Second Random Phase Approximation is formulated for superconductors, with particular attention to single-fermion states. The method proposed is applicable to spherical nuclei in the vibrational region, and to nuclei with half-filled subshells, where the effects of the superconducting energy gap are quite pronounced. (T.F.H.)

13134 AUGER ELECTRON EJECTION FROM SUPERCONDUCTING METALS. R. A. Craig (Univ. of Illinois, Urbana). Nuovo Cimento (10), 27: 257-60(Jan. 1, 1963). (In English)

The spectrum of Auger electrons emitted from a superconducting metal is compared with that of the normal metal within the Bardeen-Cooper-Schrieffer model. Since pairing may be neglected outside the metal, the only differences would come from the change in densities of states. No difference in spectra is calculated. (auth)

13135 INVESTIGATION OF THE JET OF A PLASMA GENERATOR. L. I. Grechikhin and V. D. Shimanovich. Opt. Spectry (USSR) (English Transl.), 13: 358-9(Nov. 1962).

Study of a plasma jet and the spectrum it emits reveals the jet to actually consist of several separate jets. The luminous jet of the plasma generator is found to be supersonic, producing shock waves. Increased temperature at the front of the shock wave produces lines with high energy levels. (D.C.W.)

13136 THE RELATIONSHIP BETWEEN THE SELF-ABSORPTION OF SPECTRAL LINES AND THEIR TOTAL INTENSITIES, AND THE b VALUES FOR SEVERAL LINES EXCITED IN THE VAPOR JET OF A SPARK DISCHARGE. I. S. Fishman. Opt. Spectry. (USSR) (English Transl.), 13: 360-2(Nov. 1962).

The connection between the self-absorption and total intensities of spectral lines is considered for various non-uniformity parameters of the source. A general method is suggested for determining the physical parameters of the discharge and the characteristics of spectral lines, based on comparison of calculation with the experimental data. Self-absorption and total intensity values of several nickel lines are given. (D.C.W.)

13137 OBSERVATION OF QUASI-REVERSIBLE MAGNETIC BEHAVIOR IN A SUPERCONDUCTOR OF THE SECOND KIND. G. Bon Mardion, B. B. Goodman, and A. Lacaze (CNRS, Grenoble, France). Phys. Letters, 2: 321-2(Nov. 1962). (In French)

There is found to be no magnetic hysteresis effect in a pure superconducting Pb crystal. Pb-Tl alloys containing 2.5 to 50 at. % Tl are found to exhibit hysteresis, and the parameters of their magnetization curves are given. It is concluded that the hysteresis is an effect of defects extending through the lattice, and that these defects owe their existence to the microstructure in the mixed state. (T.F.H.)

13138 INFLUENCE OF COLD-ROLLING AT 78°K ON THE SUPERCONDUCTING TRANSITION OF LEAD. W. F. Druyvesteyn and D. J. Van Ooijen (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 2: 328-9(Nov. 1962). (In English)

Lead wires were rolled at 78°K to 120% increase of length and the superconducting transition was measured at 4.2°K in a longitudinal magnetic field at several current densities (j). The critical field (H) was defined as the field that restores half the normal resistance to the wire. The wire was annealed at six different temperatures and after each annealing the j-H characteristic at 4.2°K was determined. The resistivity decrease as the sample is annealed at various temperatures was also measured. (H.D.R.)

13139 DECAY OF POSITRONIUM IN TEFLON. G. Fabri, E. Germagnoli, and G. Randone (Laboratori Centro Informazioni Studi Esperienze, Milan). Phys. Letters, 3: 6-8(Nov. 15, 1962). (In English)

Delay measurements for γ-rays emitted in annihilation of positrons involving a well determined electron movement have been performed in Teflon. The lifetime of differently processed specimens varied from 2.6×10^{-9} to 3.3×10^{-9} seconds at room temperature. The annihilation quanta angular correlation curve and delay curves are presented and discussed. (H.D.R.)

13140 MAGNETIC PROPERTIES OF A SUPERCONDUCTOR OF THE SECOND KIND. T. Kensel, E. A. Lynton, and B. Serin (Rutgers Univ., New Brunswick, N. J.). Phys. Letters, 3: 30-1(Nov. 15, 1962). (In English)

Magnetization measurements were made on an In + 2.5 at.% Bi specimen between the transition temperature and 1.31°K. The parameter n of the Ginzberg-Landau theory was determined from the data in four different and largely independent ways. The agreement and self-consistency of the results appear to verify the Ginzburg-Landau-Albrikosov model of superconductors of the second kind, at least for low values of n. (H.D.R.)

13141 MEASUREMENTS OF THE CROSS SECTION FOR THE PRODUCTION OF HYDROGEN ATOMS IN THE METASTABLE EXCITED 2S STATE. L. Colli, F. Cristofori, G. E. Frigerio, and P. G. Sona (Università Milan and Laboratori C.I.S.E., Milan). Phys. Letters, 3: 62-3 (Dec. 1, 1962). (In English)

A beam of 7 to 40 kev variable energy protons was used for the production of atoms in the metastable 2S-state by a charge exchange mechanism in helium and hydrogen gases. The production and total cross sections were measured and compared to theoretical values. There is good agreement between the experimental and theoretical values of the production cross sections above 23 kev. (H.D.R.)

13142 SOME EXPERIMENTAL CONSEQUENCES OF CONFORMAL INVARIANCE AT EXTREMELY HIGH ENERGIES. H. A. Kastrup (Universität Munich). Phys. Letters, 3: 78-80(Dec. 1, 1962). (In English)

It is conjectured that in atomic physics the conformal transformations in space-time (scale transformations $X^{\mu'} = \rho X^{\mu}$, where $\rho > 0$ and $\mu = 0, 1, 2, 3$, and special conformal transformations $X^{\mu'} = \sigma^{-1}(X)\,(X^{\mu} - C^{\mu}X^2)$, $\sigma(X) = 1 - 2C \cdot X + C^2X^2$, where C^{μ} are the four independent parameters of the Abelian group) become important either if the masses of the particles vanish or if their energies are so extremely high that their masses or any other atomic states of discrete energy are negligible. These conjectures are confirmed, and physically interesting interactions are discussed that are invariant under the groups mentioned. (H.D.R.)

13143 KOHN EFFECT AND THE LATTICE VIBRATION FREQUENCY DISTRIBUTION IN METALS. J. Peretti, I. Pelah, and W. Kley (Euratom, Ispra, Italy). Phys. Letters, 3: 105-6(Dec. 1, 1962). (In English)

Kohn has shown how the screening of the lattice vibrations in a metal by the conduction electrons results in a singular behavior of the frequency $\omega(q)$ on a certain surface S. It is shown here that in certain circumstances this Kohn effect produces some additional peaks in the frequency distribution $g(\omega)$ of the lattice, which can be clearly distinguished from those due to the usual dispersion of the lattice waves. (H.D.R.)

13144 THE GENERALISATION OF THE WIGNER-RACAH ANGULAR MOMENTUM CALCULUS. L. C. Biedenharn (Duke Univ., Durham, N. C.). Phys. Letters, 3: 154-6(Jan. 15, 1963). (In English)

It is shown that for unitary unimodular groups there exists a canonical labeling scheme that is not arbitrarily but uniquely chosen by the group itself. (C.E.S.)

13145 QUANTUM SYMMETRY EFFECTS IN HYDROGEN GAS. A. Hartland and M. Lipsicas (Rutgers Univ., New Brunswick, N. J.). Phys. Letters, 3: 212-13(Jan. 15, 1963). (In English)

The nuclear magnetic resonance technique was used to measure diffusion at 20.35°K in normal hydrogen gas and in a mixture of 37.5% ortho-hydrogen-62.5% parahydrogen gas. Results showed that ortho-molecules in different spin quantum states must actually be treated as distinguishable particles in calculating the measured diffusion cross sections. (C.E.S.)

13146 HYSTERESIS IN SUPERCONDUCTING PHASE TRANSITIONS IN TIN FILMS. J. P. Baldwin (Mullard Research Labs., Redhill, Surrey, Eng.). Phys. Letters, 3: 223-6(Jan. 15, 1963). (In English)

Specimen profiles were cut using razor blades. During the parallel field measurements the films were carefully aligned with the magnetic field produced by an accurately calibrated solenoid; the earth's field was cancelled using Helmholtz coils. The transition widths of a few oersteds with parallel fields were found to be independent of temperature and film thickness. (C.E.S.)

13147 MAGNETIZATION CURVES IN A SUPERCONDUCTOR OF THE SECOND KIND. S. H. Goedemoed, A. Van der Giessen, D. De Klerk, and C. J. Gorter (Kamerlingh Onnes Laboratorium, Leiden). Phys. Letters, 3: 250-1(Jan. 15, 1963). (In English)

Magnetization curves of impure niobium wire were investigated in parallel fields up to 4500 oersteds. Five hundred wires with a length of 11 cm and a diameter of 0.01 cm were stuck together by means of nitrocellulose resin around a constantan wire of 0.02 cm diameter. The bundle was suspended vertically in a helium gas atmosphere inside a glass tube surrounded by liquid helium. By adjusting a current through the constantan wire the temperature could be varied up to several degrees above the helium boiling point. Three magnetization curves and two remanence curves were observed at different temperatures. (C.E.S.)

13148 SATURATED He^4 NEAR ITS CRITICAL TEMPERATURE. M. H. Edwards and W. C. Woodbury (Royal Military Coll., Kingston, Ont.). Phys. Rev., 129: 1911-18 (Mar. 1, 1963).

Measurements of the refractive index n of saturated He^4 liquid and vapor have been made at $\lambda = 5462.27$ Å from 4.2°K nearly to the critical temperature ($T_c = 5.1994$°K). Careful determinations of n and dn/dT as a function of temperature were made using a metal optical cryostat and a Jamin interferometer modified to produce a chart record of the interference fringes. The measurements extended to within 50 mdeg of T_c for saturated vapor, and to within 36 mdeg of T_c for saturated liquid. These results, combined with the Lorenz-Lorentz equation, then give the density ρ of both saturated liquid and saturated vapor, and the expansion coefficient β_s of the saturated liquid. These n, ρ, and β_s measurements are the first ever made above 4.4°K except for two early measurements of density at 4.6 and 4.7°K. The critical density is found to be $\rho_c = (0.06948 \pm 0.00030)$ g cm^{-3}, or the critical molar volume, $V_c = (57.628 \pm 0.25)$ cm^3 mole^{-1}. The Landau-Lifshitz theory of the properties of a substance "near" the critical point is extended, and excellent agreement is found with experimental values of the molar volumes of saturated He^4 within about 110 mdeg of T_c. This agreement is taken as evidence that $(\partial^3 P/\partial V^3)_T$ is negative at the critical point, in clear contradiction to theories which suggest that this third derivative is zero at T_c. In terms of the "reduced" parameters $V' = V/V_c$ and $P' = P/P_c$, $(\partial^3 P'/\partial V'^3)_{T_c} = -(10.4 \pm 1.8)$ for He^4. In addition, saturated vapor and liquid molar volumes and liquid coefficient of expansion values can be calculated right up to the critical temperature, assuming the continued validity of the modified Landau-Lifshitz theory. (auth)

13149 ELECTRON-SPIN PARAMAGNETIC RESONANCE STUDIES OF NEUTRON-IRRADIATED LiF. R. Kaplan and P. J. Bray (Brown Univ., Providence, R. I.). Phys. Rev., 129: 1919-35(Mar. 1, 1963).

The electron-spin resonance spectra of F centers in neutron-irradiated crystals of Li^6F, Li^7F, and LiF of normal isotopic content have been studied in order to test existing theories of F-center resonance absorption. The spectrum for Li^6F has several interesting features and confirms the ENDOR measurements of Holton, Blum, and Slichter for crystals of normal isotopic content. Specimens of the latter composition have been subjected to a wide range of neutron doses in the present work and their spectra examined. For doses smaller than about 10^{17} n/cm^2 the spectra exhibit a resolved hyperfine structure on a Gaussian envelope. For doses exceeding 10^{17} n/cm^2, changes are observed in resonance linewidth, shape, and spin-lattice relaxation time. The observations appear to be consistent with the view that the radiation-induced defects are not uniformly distributed in the crystals. Exchange interactions between paramagnetic defects in regions of high defect concentration appear to be responsible for the observed changes in the resonance spectra as the neutron dose is increased. Crystals which received doses in excess of 10^{19} n/cm^2 exhibit resonance absorption characteristic of conduction electrons in small particles of lithium metal. Annealing and saturation studies give some information regarding the spin-lattice relaxation of the conduction electrons in the metal particles. (auth)

13150 MAGNETIC PROPERTIES OF SUPERCONDUCTING LEAD-BASE ALLOYS. J. D. Livingston (General Electric Research Labs., Schenectady, N. Y.). Phys. Rev., 129: 1943-9(Mar. 1, 1963).

Magnetization measurements have been made at 4.2°K on a variety of binary lead-base alloys, with the purpose of determining the effects of solutes, precipitates, and dislocations on superconducting properties. Increasing solute concentration results in increasingly broad magnetic transitions, the results correlating with normal-state electron mean free path in quantitative agreement with "negative surface energy" theories of Abrikosov and others. Magnetic hysteresis and trapped flux are small for annealed

single-phase specimens, but are greatly increased by plastic deformation and by cellular precipitation. The maximum magnetic field to which superconductivity persists in these alloys is apparently determined by the electron mean free path, whereas extended defects such as dislocations and precipitates are primarily responsible for magnetic hysteresis and trapped flux. (auth)

13151 COMPRESSION OF SOLID He^3 AND He^4 TO 20 000 BARS. John W. Stewart (Univ. of Virginia, Charlottesville). Phys. Rev., 129: 1950-1(Mar. 1, 1963).

For purposes of comparison, the compression of both solid He^3 and He^4 at 4.2°K up to 20,000 bars pressure was measured. The relative volume changes of the solid samples were measured in a direct piston displacement apparatus. It was found that both isotopes fit a Murnaghan finite strain relation. From this compressibilities were computed. Within experimental error, the two isotopes have the same compressibility throughout the range. As might be expected from its larger zero-point energy, He^3 has the slightly greater molar volume at all pressures. (auth)

13152 CHARACTERISTICS OF THE PENETRATION DEPTH OF SUPERCONDUCTING INDIUM ALLOYS. R. A. Connell (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 129: 1952-8(Mar. 1, 1963).

The relative penetration depths of a series of In–Sn, In–Tl, and In–Pb alloy specimens were measured at 700 kc/sec with and without a longitudinally applied d-c magnetic field. In the dilute range the zero-field penetration depth showed a mean free path dependence roughly proportional to the one-half power of the resistivity, in accordance with previous work, but for samples with resistivities exceeding approximately 1.3 $\mu\Omega$ cm the effective penetration depth became anomalously large, indicating filamentary behavior. Measurements of the magnetic field dependence failed to show the decrease in penetration depth with applied field found by experimenters working at microwave frequencies; instead there was reasonable agreement with the predictions of the Ginzburg-Landau theory. The experimentally estimated values of the parameter κ at which filamentary characteristics appeared were of the order of 0.8 ± 0.05 as compared to the theoretically derived critical value of $1/\sqrt{2}$. (auth)

13153 TEMPERATURE DEPENDENCE OF NUCLEAR MAGNETIC RESONANCE OF Fe^{57} IN MAGNETITE. E. L. Boyd (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev., 129: 1961-4(Mar. 1, 1963).

A report is made of an attempt to fit the temperature dependence of the observed nuclear magnetic resonance (NMR) frequencies for the two sublattices in magnetite to the measured temperature dependence of the magnetization. It is shown that when the microwave g_{eff} values as reported in the literature are used in this calculation, no fit between the NMR experiment and the moment measurement is obtained. If a $g_{eff} = 2$ is assumed, however, the data may be brought into good agreement. (auth)

13154 ELECTRICALLY INDUCED NUCLEAR QUADRUPOLE SPIN TRANSITIONS IN A GaAs SINGLE CRYSTAL. E. Brun, R. J. Mahler, H. Mahon, and W. L. Pierce (Univ. of Colorado, Boulder). Phys. Rev., 129: 1965-70 (Mar. 1, 1963).

The direct induction of nuclear E2 spin transitions in a gallium arsenide single crystal by application of an external oscillatory electric field has been previously reported. This paper gives the results of a further investigation of the same phenomenon. Theoretical expressions are given for the equilibrium nuclear magnetization in a crystalline lattice under the combined influence of a static magnetic field, externally induced electric field gradients, and thermal spin-lattice interactions, for various relative orientations of the applied fields and the crystalline symmetry axes. The theoretical predictions were tested for the three nuclides Ga^{69}, Ga^{71}, and As^{75} by using pulsed nuclear magnetic resonance techniques to sample the equilibrium magnetization in a GaAs crystal at 77°K under the influence of a uniform, externally applied, radio-frequency, electric field. A description of the experimental apparatus is given. The dependence of the quadrupolar saturation on both the electric field amplitude and the crystal orientation was measured. The angular dependence of the saturation was found to be in reasonable agreement with the theory. (auth)

13155 DE HAAS–VAN ALPHEN EFFECT IN A ZINC ALLOY EXHIBITING A RESISTANCE MINIMUM. F. T. Hedgcock and W. B. Muir (Franklin Inst. Labs., Philadelphia). Phys. Rev., 129: 2045-54(Mar. 1, 1963).

The de Haas-van Alphen effect has been measured using a torque method at magnetic fields up to 8 kOe and temperatures between 4.2 and 1.6°K for both pure zinc and a zinc-manganese alloy exhibiting a resistance minimum. Experimentally, it is shown that there is no change in the period of the oscillations although the field and temperature dependence of the amplitude of the oscillations is found to be anomalous. A consideration of the influence of the conduction electron relaxation time on the de Haas-van Alphen effect shows that the observed behavior may be explained if the relaxation time is allowed to approach zero in a small energy interval, Δ, about the Fermi energy. Using the phenomenological theory of the resistance minimum, due to Korringa and Gerritsen, and the value of Δ obtained from the de Haas-van Alphen effect experiments, the resistance as a function of temperature was calculated and found to agree within experimental error with the measured values. (auth)

13156 LOW-ENERGY ELECTRON SCATTERING FROM ATOMIC NITROGEN. R. H. Neynaber, Lawrence L. Marino, Erhard W. Rothe, and S. M. Trujillo (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 129: 2069-71(Mar. 1, 1963).

The total cross section for the scattering of electrons by atomic nitrogen has been measured as a function of electron energy from 1.6 to 10 ev. An electron gun was developed that produced a more intense beam of electrons than was used for similar experiments with atomic hydrogen and atomic oxygen. The number of electrons scattered from a region defined by the intersection of an electron beam and a modulated molecular nitrogen beam was compared with the number scattered when the nitrogen beam was partially dissociated. A pulsed d-c discharge dissociated about 20% of the molecules. The degree of dissociation was measured with a mass spectrometer. From the data, the ratios of atomic to molecular scattering cross sections were obtained. The absolute atomic values were calculated by multiplying these ratios by the molecular nitrogen cross sections obtained by Normand. The results are compared with theoretical estimates of the cross section. (auth)

13157 THEORY OF INDIRECT EXCHANGE INTERACTIONS IN RARE-EARTH METALS. T. A. Kaplan (Massachusetts Inst. of Tech., Lexington) and D. H. Lyons. Phys. Rev., 129: 2072-86(Mar. 1, 1963).

Liu has recently considered the effect of nonzero atomic

orbital angular momentum on the exchange interactions between a localized magnetic moment and conduction electrons. By expanding a part of the band wave functions in spherical harmonics, he found that the leading term gave rise to the familiar scalar product interaction between conduction electron spin and total atomic angular momentum J. In the present paper, we derive Liu's result by a simpler calculation, and obtain the first correction term in a similar expansion. Our main motivation in doing the latter is to investigate the validity of the common use of the leading term only, doubt being raised, a priori, by the fact that the Fermi wave vector times the radial extent of the 4f function is not $\ll 1$. We then investigate, in second-order perturbation theory, the magnetic interaction between atoms n and m. The leading term is, of course, an isotropic Heisenberg-type interaction $A^{(0)}_{nm}\mathbf{J}_n \cdot \mathbf{J}_m$ corresponding to Liu's result. The first correction term gives rise to anisotropic interactions including pseudodipolar forces and an unconventional interaction which is quartic in the J's. An estimate for rare-earth metals, based on free conduction electrons and screened hydrogenic localized functions, suggests that the comparative importance of the correction term is very sensitive to the number of 4f electrons and also to the lattice structure. For Tb through Er, it appears that the leading term does dominate, the correction being roughly 10%; for Tm metal the correction term is ~30%, whereas for a single pair of Tm^{3+} ions it is ≈80%. The leading term is also considered using the same type of one-electron functions. This gives roughly the right order of magnitude for the Curie temperature and the correct signs for first- and second-neighbor interactions; also the ratio of the latter interactions is in rough agreement with experiment. (auth)

13158 POTENTIAL AND KINETIC ELECTRON EJECTION FROM MOLYBDENUM BY ARGON IONS AND NEUTRAL ATOMS. D. B. Medved, P. Mahadevan, and J. K. Layton (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 129: 2086-7(Mar. 1, 1963).

The yield of secondary electrons γ_n, from cleaned surfaces of polycrystalline molybdenum, has been measured for argon neutral atoms (Ar^0) in the energy range 500 to 2500 ev. The values of γ_n thus obtained are compared with γ_i, the yield for argon ions previously determined. It is found that the rates of increase of γ_i and γ_n with energy E are not equal in the region of kinetic ejection. The ratio $(d\gamma_i/dE)/(d\gamma_n/dE)$ is 1.5. The result indicates that assumed models concerning the respective contributions of potential and kinetic ejection to the secondary electron yield at energies above 1000 ev should be modified. (auth)

13159 ANGULAR CORRELATION PERTURBED BY AN ANISOTROPIC HYPERFINE INTERACTION. H. J. Leisi and R. T. Deck (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 129: 2117-29(Mar. 1, 1963).

A theoretical investigation is made of the effect on a gamma-gamma angular correlation of the extranuclear perturbations which arise from the coupling between the magnetic dipole and electric quadrupole moments of the nucleus and the electromagnetic field of the electron shell in a paramagnetic crystal of axial symmetry. The hyperfine interaction is assumed to be time independent. Results are obtained for both single-crystal and polycrystalline sources. For a single-crystal source, the effect on the correlation of an external magnetic field parallel to the crystalline axis is investigated. The behavior of the correlation over the whole range of partially to fully decoupled nuclear and electronic spins is calculated. It is shown that under certain conditions an "angular correlation resonance experiment" is possible, i.e., an experiment in which the coincidence counting rate, for fixed positions of the detectors, exhibits sharp interference peaks as a function of the magnetic field. For a powder source, the attenuation factors are computed as a function of the hyperfine constants for arbitrary nuclear spin values. New possibilities for investigation of nuclear moments of excited states are discussed. (auth)

13160 SOME CONDITIONS FOR THE APPARENT VANISHING OF THE ENERGY GAP IN SUPERCONDUCTORS. H. Suhl and D. R. Fredkin (Univ. of California, San Diego). Phys. Rev. Letters, 10: 131-4(Feb. 15, 1963).

Paramagnetic impurities in one of the two superconducting films causes the energy gap to disappear in tunneling bebetween two superconductors. An expression for the change in tunneling current due to impurities is derived using perturbation theory to deal with exchange coupling between conduction electrons and impurity spins. Effect of changes in spin states with quasi-particle occupation is also examined. (D.C.W.)

13161 NUCLEAR POLARIZATION IN InSb BY A dc CURRENT. W. G. Clark and G. Feher (Univ. of California, San Diego). Phys. Rev. Letters, 10: 134-8(Feb. 15, 1963).

Production of steady-state nuclear polarization in metals by saturating the electron spin resonance absorption of the conduction electrons in an external radiofrequency field depends on the difference in temperature of electrons relaxing the nuclei and the temperature characterizing the electron velocity distribution. Enhancement of nuclear polarization in in InSb by application of a d-c current is studied, and graphs display enhancement of the nuclear resonance signal in In^{115}, Sb^{121}, and Sb^{123} as functions of time and applied electric field. Production of the necessary temperature difference by acceleration of electrons in an electric field gradient, by use of a magnetic field perpendicular to the direction of current flow, and by injection of electrons at the contacts is also discussed. (D.C.W.)

13162 ON THE EVALUATION OF PHONON WIDTHS AND SHIFTS. A. A. Maradudin, A. E. Fein, and G. H. Vineyard (Westinghouse Research Labs., Pittsburgh and Brookhaven National Lab., Upton, N. Y.). Phys. Status Solidi, 2: 1479-92(1962). (In English)

A method is described for the numerical evaluation of phonon widths and shifts due to three-phonon processes in an anharmonic crystal. With this method the δ-function and principal value restrictions on the frequencies of the phonons participating in the three-phonon processes do not have to be taken into account explicitly. The method is based on a dispersion relation satisfied by the width and shift, and on their expansion in Legendre functions of the first and second kinds, respectively. It is illustrated by a numerical example. (auth)

13163 THEORY OF THE SPIN WAVE CONTRIBUTION TO THE SPECIFIC HEAT OF DYSPROSIUM. B. R. Cooper (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 80: 1225-36(Dec. 1962).

A theory is presented for the spin wave contribution to the specific heat of dysprosium below the temperature of transition from ferromagnetic to spiral spin arrangement. The central feature of the theory is the nature of the spin wave spectrum. There is a substantial energy gap (E_g) at the minimum of the spectrum. This is caused by the large magnetocrystalline anisotropy energies present, and is of magnitude 20 to 30°K. The transition from ferromagnet to spiral implies a spectrum that is nearly flat, for wave vectors in the direction of the hexagonal axis, for an appreci-

able part of the first Brillouin zone. The energy values for this direction of wave vector then increase abruptly. Thus the spectrum is essentially two-dimensional. These properties of the spin wave spectrum lead to a spin wave specific heat that is exponential for $kT \ll E_g$ and linear for $kT \gtrsim E_g$. The relation of this theoretical behavior to the experimental results is discussed. (auth)

13164 EFFECT ON SYMMETRICAL RESONANCE CHARGE TRANSFER CROSS SECTIONS OF CHANGE IN RELATIVE MOTION DURING ENCOUNTER. D. R. Bates and Anne H. Boyd (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 80: 1301-7(Dec. 1962).

Taking into account the effect that the force between the colliding systems has on the relative motion, a formula is derived for the cross section for symmetrical resonance charge transfer. Detailed calculations are carried out on $H^+ + H(1s) \rightarrow H(1s) + H^+$ and on $He^{2+} + He^+(1s) \rightarrow He^+(1s) + He^{2+}$. In the case of the former, the effect under investigation is inappreciable; but in the case of the latter it is quite large, causing the cross section to pass through a maximum of $8.9\ \pi a_0^2$ at an energy of relative motion of about 100 ev. A simple method of allowing for the effect of a Coulomb repulsion is described. Evidence is adduced regarding the accuracy of Firsov's approximation. (auth)

13165 CHARACTERISTIC ELECTRON ENERGY LOSSES IN COMPOUNDS. P. E. Best (Univ. of Western Australia, Nedlands). Proc. Phys. Soc. (London), 80: 1308-21(Dec. 1962).

The characteristic electron energy loss spectra of thirty-two compounds, principally halides and oxides, are reported, and an explanation is given of most of the energy losses in terms of ionization, interband transitions, and longitudinal oscillations of the valence electrons. A series of energy losses in transition metal salts is associated with the transfer of an electron from an anion to a neighboring cation d shell and, where comparison with optical data is possible, agreement is satisfactory. Tables and spectra of electron energy losses in the compounds are included. 43 references. (auth)

13166 MEASUREMENT OF THE VAPOUR VELOCITY NEAR THE SURFACE OF LIQUID HELIUM II. Donald V. Osborne (Univ. of British Columbia, Vancouver). Proc. Phys. Soc. (London), 80: 1343-6(Dec. 1962).

Measurements have been made of the velocity of the helium vapor immediately above the surface of liquid helium II carrying a horizontal heat current. Below 1.7°K the vapor moves substantially with the normal fluid; above this temperature anomalously high apparent vapor velocities are observed, possibly connected with net evaporation. (auth)

13167 TEMPERATURE VARIATION OF THE EFFECTIVE GRÜNEISEN PARAMETER IN CAESIUM CHLORIDE STRUCTURES. S. Ganesan and R. Srinivasan (Indian Inst. of Science, Bangalore). Proc. Roy. Soc. (London), Ser. A, 271: 154-69(Jan. 15, 1963).

A systematic investigation of the temperature variation of the effective Grüneisen parameter, γ_{eff}, was carried out for the cesium chloride structure, on a model incorporating the Coulomb potential between the ions and a nearest neighbor interaction varying as r^{-n}. As the value of n is increased from 8 to 30, the low temperature limit γ_0 of γ_{eff} is progressively reduced, while the high temperature limit γ_∞ increases. The value of $\gamma_0 - \gamma_\infty$ is positive for $n \leq 15$ and changes sign for $n \geq 20$. Thus the trend and the extent of the temperature variation of γ_{eff} are sensitive to the value of n in the cesium chloride lattice. On the other hand in the NaCl lattice, the trend of the temperature variation of γ_{eff} is not affected by a variation of n. For $n \approx 16$, the γ_{eff} value appears to be independent of temperature, though the individual Grüneisen parameters for the lattice frequencies vary widely. This case is an example of a type of perfect Grüneisen solid, the condition for the existence of which was given by Blackman. The Houston method with a constant normalization factor is shown to yield the correct trend of the temperature variation of γ_{eff}. A more elaborate normalization procedure alters the γ_{eff} values only slightly. Varying the ratio of the ionic masses has only a slight effect on $\gamma(p)$ and γ_{eff}. From the recently measured elastic data, it appears probably that the value of n pertinent to the cesium halides is about 15. n may increase slightly with increasing size of the anion. If this value of n is correct, the effective Grüneisen parameters for the cesium halides must vary only slightly with temperature. Probably one of the cesium halides will exhibit closely the behavior of a perfect Grüneisen solid. (auth)

13168 PARAMAGNETIC RESONANCE AND OPTICAL ABSORPTION OF TRAPPED HOLES AND ELECTRONS IN IRRADIATED KCl : Ag. C. J. Delbecq (Argonne National Lab., Ill.), W. Hayes, M. C. M. O'Brien, and P. H. Yuster. Proc. Roy. Soc. (London), Ser. A, 271: 243-67(Jan. 15, 1963). (TID-16865; UAC-6657)

The electron spin resonance and optical absorption spectra of crystals of KCl containing silver impurity ions were examined after the crystals had been x-irradiated at 77°K. It is shown that the silver impurity ions act as traps for both electrons and positive holes. A description is given of the annealing behavior of the crystals after low-temperature irradiation. (auth)

13169 INELASTIC SCATTERING OF ELECTRONS BY CRYSTALS. I. THE THEORY OF SMALL-ANGLE INELASTIC SCATTERING. A. Howie (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 271: 268-87(Jan. 15, 1963).

The theory of inelastic scattering is studied for the transmission of fast electrons through crystals when the fast electrons are described by Bloch waves so that Bragg reflection is also considered. Solutions for the wave amplitudes are obtained for the case of small-angle inelastic scattering and it is shown that interband inelastic scattering transitions of the fast electron are forbidden when the interaction potential is of the long range type which might arise in the excitation of plasmons. This result would explain recent electron microscope observations of similar diffraction contrast effects obtained using elastically scattered or inelastically scattered electrons, and also shows that such inelastic scattering need not be considered in theories of diffraction contrast. The theory also predicts a Poisson distribution for the intensities of the various peaks observed in the energy spectrum of the transmitted electrons. In thick crystals, where anomalous absorption effects are important, the angular distribution of the scattered intensity round the Bragg diffraction spots is found to contain an asymmetry in qualitative agreement with the experimental observations. (auth)

13170 THE CROSS-SECTION FOR IONIZATION OF O^{3+} BY ELECTRON IMPACT. Eleonore Trefftz (Max-Planck-Institut für Physik und Astrophysik, Munich). Proc. Roy. Soc. (London), Ser. A, 271: 379-86(Jan. 22, 1963).

The calculation of ionization cross-sections is described. For O^{5+} a Coulomb-Born-Oppenheimer method is used. Previous calculations for O^{4+} with the distorted wave method are corrected and extended. The results are given

in tables and in figures. For O^{4+} (ionization energy E_i = 8.37 × 13.6 eV) the cross-section Q has its maximum at an energy of the incident electron $E = 2.3E_i$: $Q_{max.} = 2.74 \times 10^{-2}\pi\alpha_0^2 = 2.42 \times 10^{-18}$ cm^2. For O^{5+} (E_i = 10.15 × 13.6 ev) the maximum is at $E = 1.85E_i$: $Q_{max.} = 0.97 \times 10^{-2}\pi\alpha_0^2 = 0.86 \times 10^{-18}$ cm^2. The corresponding reduced cross-sections $Q_{red.} = (E_i/13.6 \text{ ev})^2 \times Q/(\zeta\pi\alpha_0^2)$ are for O^{4+} ($\zeta = 2$): $Q_{red.} = 0.96$, and for O^{5+} ($\zeta = 1$): $Q_{red.} = 1.00$. The results are similar to those of Rudge & Burgess for hydrogenic ions. (auth)

13171 GAUGE INVARIANCE OF THE G TENSOR. A. J. Stone (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 271: 424-34(Jan. 22, 1963).

The usual theory of g tensor values cannot be applied to molecules as it is not gauge-invariant. Dirac's wave equation is used to derive a gauge-invariant theory, and a general expression is obtained for the principal g values of a molecule in an orbitally non-degenerate state. An approximate formula for g values is also derived. (auth)

13172 MEASUREMENT IN QUANTUM MECHANICS. III. MACROSCOPIC MEASUREMENT AND STATISTICAL OPERATORS. Hitoshi Wakita (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1156-64(June 1962). (In English)

It is shown how "macroscopic measurement," that is, measurement that does not affect the states of a macro-system in the classical sense, changes a pure state into some kind of mixed state in quantum mechanics. The theory is grounded on the theory of measurement, but its main part is an improved version of the von Neumann theory of measurement. The introduction of the notion of a "statistical ensemble" is necessitated in the theory, and this notion has an intimate connection with that in quantum statistics. (auth)

13173 MAGNETIZATION PROCESS OF A SCREW SPIN SYSTEM. Takeo Nagamiya (Osaka Univ.), Kazukiyo Nagata, and Yoshiharu Kitano. Progr. Theoret. Phys. (Kyoto), 27: 1253-71(June 1962). (In English)

The effect of an external magnetic field on the screw structure of spin arrangement at absolute zero is studied, for the case where the field is applied perpendicularly to the screw axis. First, the anisotropy energy that confines the spin vectors in the plane perpendicular to the screw axis is assumed to be so large that for any strength of the field the spin vectors remain in that plane. For weak fields, the change of the screw structure resulting from the field is calculated as a power series of the field strength. The calculation of the energy of the system is carried out up to the fourth power. Singularities appear for turn angles of 90 and 180°. For high fields, expansion in powers of the deviation angles of the spin vectors from the field direction is made, and it is shown that there is a critical field, H_0, above which the vectors are all parallel to the field direction and below which they oscillate sinusoidally about the field direction with an amplitude proportional to $(H-H_0)^{1/2}$. Phase transition between the screwing and sinusoidally oscillating structures at an intermediate field strength is discussed. In the neighborhood of turn angles of 90, 180, and 60°, there appear regions of stability of doubly antiferromagnetic, antiferromagnetic, and triangular arrangements. The assumption for the anisotropy energy is relaxed, and phase transitions between the screwing, cycloidal (more strictly, elliptically conical), and sinusoidally oscillating structures are studied for small turn angles. (auth)

13174 THEORY OF GYROMAGNETIC EFFECTS AND SOME RELATED MAGNETIC PHENOMENA. S. P. Heims (Brandeis Univ., Waltham, Mass.) and E. T. Jaynes. Revs. Modern Phys., 34: 143-65(Apr. 1962).

A unified theory of atomic and macroscopic gyromagnetic phenomena and ordinary magnetic polarization is given. Nuclear gyromagnetic effects and nuclear magnetic-field polarization are also considered. The dynamics of spin systems are considered, in order to derive the quantum-mechanical Larmor equation. The equilibrium gyromagnetic-magnetic theory is treated in detail. Time-dependent behavior of nuclear spins in rotating crystals is examined. (T.F.H.)

13175 LIQUID AND SOLID He^3. N. Bernardes (Iowa State Univ., Ames) and D. F. Brewer. Revs. Modern Phys., 34: 190-214(Apr. 1962). (IS-485)

A theoretical and experimental review of the properties of liquid and solid He^3 is presented. Properties of He^3–He^4 mixtures are also considered. (T.F.H.)

13176 EXPLICIT REPRESENTATION OF DISCRETE-SYMMETRY OPERATORS IN QUANTUM THEORY OF FREE FIELDS. K. H. Mariwalla (Univ. of British Columbia, Vancouver and Univ. of Georgia, Athens). Revs. Modern Phys., 34: 215-26(Apr. 1962).

The discrete-symmetry operators of free fields are considered, from the point of view of their explicit representation in terms of the creation and annihilation operators of the fields in question. The formalisms and notations for the Klein-Gordon, Dirac, and electromagnetic fields are outlined, and the transformation properties of the field functions and of the corresponding annihilation operators under various discrete-symmetry transformations are tabulated. The representations for all the discrete-symmetry operators are then given for these three fields. (T.F.H.)

13177 RESULTS OF A STATISTICAL STUDY OF GEOMAGNETIC DISTURBANCES FOR FIVE CYCLES OF SOLAR ACTIVITY. É. R. Mustel' (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 19-30(July-Aug. 1961).

A statistical analysis of the relations between plages and geomagnetic disturbances is given for five cycles. In order to weaken the role of flares (high activity) and the influence of disturbances with an anomalously long duration ΔT (lowest activity), only those parts of the descending curves of activity are considered for which the relative sunspot number is less than 75 and exceeds 15–20. The plages are divided into two groups: a) Plages of Group I. To this group belong plages which during their central meridian passage crossed the apparent center of the disk or were adjacent to the center. b) Plages of Group II. The heliocentric angle ψ_0 of these plages satisfies the inequality $\psi_0 \geq 6°$. Group II is divided into two subgroups: II_f – is related to the favorable hemisphere and II_u – to the unfavorable hemisphere. All the dependences given are obtained by the superposed epoch method. The periods studied for cycles No. 14 and 15 are divided so as to show the persistence of the right maximum (thick line) and the completely irregular accidental character of the curves to the left of CMP. General results for the whole period 1906-1951 are given. The general conclusion is that the only stable formation in all statistical curves is the right maximum, characterized by a very small dispersion of points and having a direct physical meaning. The probability that the right maximum of the curves is accidental (taking into account the fact that the dependences obtained for Group II have no maxima) is very small. These results wholly confirm the previous conclusions that the active regions themselves are the source of streams responsible

for M disturbances and that these streams are approximately radial. This conclusion is in agreement with the recent radio astronomical and polarimetric conclusions according to which the corona has increased density only above active regions. (auth)

13178 ON THE NATURE OF THE EAST-WEST ASYMMETRY OF SOLAR ACTIVITY. P. R. Romanchuk (Kiev State Univ.). Soviet Astron. AJ (English Transl.). 5: 46-52(July-Aug. 1961).

The problem of the east-west asymmetry is reconsidered. An expression is obtained for the theoretical distribution of the centers of appearance of sunspot groups on the disk. It is shown that the time of preliminary development t_0 depends on the interval of time between two successive observations of spot groups. The theoretical distribution of the centers of appearance for 5 years is obtained quantitatively, the following being determined from observations of 1927, 1935, 1941, 1945-1946: the time of preliminary development of groups t_0 (found to be close to 0.5d); the angular velocity of motion of spot groups on the disk and the mean number of spots n, originating in a unit interval of longitude. The observed distribution of the centers of appearance of developing groups, characterized by a maximum near the eastern limb, is found for the same periods. The application of Pearson's χ^2 test shows that there is an appreciable difference between the theoretical and observed distributions. The result is checked by means of a combined curve for 40 years of observations. It is concluded that the east-west asymmetry cannot be considered to be the result of the conditions of observation. (auth)

13179 NEW CLASSES OF PERIODIC SOLUTIONS IN THE RESTRICTED PROBLEM OF THREE BODIES. V. G. Demin (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 114-19(July-Aug. 1961).

The plane restricted circular problem of three bodies in Thiele's elliptical variables is considered. Using Poincaré's method of the small parameter it is shown that there exist periodic orbits in the vicinity of one of the attracting masses. The orbits of the problem of two fixed centers are adopted as initial orbits. (auth)

13180 DISCONTINUOUS CENTRAL-SYMMETRIC MOTIONS OF ULTRARELATIVISTIC GAS IN THE GENERAL THEORY OF RELATIVITY. V. A. Skripkin (Mathematical Inst., Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 143-5(July-Aug. 1961).

An exact nonstationary discontinuous solution of the equations of the general theory of relativity is obtained, assuming a central-symmetric field produced by moving ultrarelativistic gas. The solution can have astrophysical applications. (auth)

13181 VARIATIONS OF THE MAGNETIC FIELD AND SUNSPOT CONFIGURATIONS DURING SOLAR FLARES—A DETERMINATION OF THE TOTAL ENERGY OF FLARES. S. I. Gopasyuk (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 158-64(Sept.-Oct. 1961).

Recordings of the magnetic field in active regions, taken with a magnetograph, and photographs of the sun in integral light, show that the "humps" of the magnetic field and sunspots move during a flare. The onset of such motions coincides to within 5 minutes with the beginning of flare development. The magnitude of the displacement varies from case to case, and often reaches 20,000 km. The motion of the "humps" and sunspots are, as a rule, toward flare nodes. The energy liberated is estimated on the assumption that the displacement of the "humps" and sunspots toward flares is associated with contraction resulting from the conversion of magnetic energy into the thermal energy of the flare. The energy of a flare is found to be of the order of 10^{32} ergs. (auth)

13182 HELIUM EXCITATION AND THE STRUCTURE OF THE LOWER CHROMOSPHERE. É. V. Kononovich (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 165-70(Sept.-Oct. 1961).

The occupations of the ortho- and parahelium levels are calculated, and it is shown that the observed helium-line intensities impose special conditions on the structure of the lower chromosphere. Helium is excited in "hot" regions, with dimensions of not more than 700 km, which are surrounded by "cold" regions. The intensity of ultraviolet radiations generated in the "hot" regions corresponds to radiation temperature of about 11,000°, the kinetic temperature being of the order of 15,000°. This untraviolet radiation is completely absorbed by the "cold" regions with temperatures close to 6000° and, therefore, cannot be observed. The helium radiation in the visible spectral region passes freely through all the chromospheric regions. At a height of 3000 km, the "hot" chromospheric regions can occupy about one-half of the total volume. (auth)

13183 QUANTITATIVE ANALYSIS OF THE STATISTICAL RELATIONS CONNECTING PLAGES AND M-DISTURBANCES. É. R. Mustel' and S. A. Aivazyan (Astronomical Council, Academy of Sciences, USSR and Steklov Mathematical Inst., Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 171-81(Sept.-Oct. 1961).

The relation between "central" and "noncentral" plages on the one hand and geomagnetic M-disturbances on the other is quantitatively discussed. Statistical data are used. The principal conclusions are: (1) The strength of the earth's magnetic field under the influence of "noncentral" plages remains (on the average) independent of time. (2) In the case of "central" plages, the mean level of M-disturbances changes with time according to a definite and stable law a(t); this relation has (approximately) the form of a broken line with a clearly marked maximum near the point $t \approx +6^d$. The likelihood of the appearance of a sequence by chance with deviations from the theoretical sequence equal to, or larger than, those observed, is lower by a factor of 3.1×10^9 when the theoretical sequence is calculated, assuming that the mean level of geomagnetic disturbances varies with time as a(t) (discontinuous line) than when it is calculated on the assumption of a constant time-independent mean level. Several methods in probability theory and mathematical statistics are used (analysis of variance, χ^2-test, regression analysis, method of least squares, etc.). (auth)

13184 ONE CLASS OF PERIODIC SOLUTIONS IN THE RESTRICTED THREE-BODY PROBLEM. E. P. Aksenov (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 249-54(Sept.-Oct. 1961).

The restricted circular three-body problem is considered. The assumption that one of the finite masses is small is not made. The existence of a new class of spatial periodic solutions of this problem is proved, and the first terms of the series representing these solutions are obtained. The orbits which correspond to these solutions include both of the attracting bodies. A peculiarity of the orbits obtained is that their nodes exhibit secular motion. (auth)

13185 THE IONIZATION AND EXCITATION OF HYDROGEN. II. THE NUMBER OF OBSERVED LINES IN A

SERIES. G. S. Ivanov-Kholodnyi and G. M. Nikol'skii (Inst. of Applied Geophysics and Inst. of Terrestrial Magnetism, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 339-43(Nov.-Dec. 1961).

The number of levels and the population of upper levels of hydrogen are considered. It is shown that there is a lowering of the ionization continuum and a decrease in the population of the high levels, as compared with the Boltzmann distribution, due to diffuseness of the levels as a result of the impact effect. The population of the upper levels and the number of lines in the series are estimated. (auth)

13186 A PARTICULAR CASE OF THE RESTRICTED THREE-BODY PROBLEM WITH VARIABLE MASSES. E. P. Razbitnaya. Soviet Astron. AJ (English Transl.), 5: 393-5(Nov.-Dec. 1961).

Equations of motion are obtained for a particle in the restricted three-body problem with variable finite masses for which Kepler's third law holds at any moment of time. When the finite masses are subject to a particular law of decrease, an integral is given which is analogous to Jacobi's integral in the restricted three-body problem with constant masses. (auth)

13187 ON THE CONNECTION BETWEEN TYPE III ABSORPTION AND ERUPTIVE ACTIVE REGIONS ON THE SUN. A. S. Besprozvannaya and V. M. Driatskii (Arctic and Antarctic Scientific Research Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 467-70(Jan.-Feb. 1962).

The possible role of eruptive-active regions on the sun in the generation and storage of charged particles with energies of 10-100 Mev, responsible for anomalous absorption in the ionosphere at high latitudes, is discussed. It is proposed that large chromospheric flares, which are followed by Type III absorption, serve as a "trigger mechanism" for the escape from the sun of fast particles stored in eruptive regions. (auth)

13188 THE ZEMPLENE THEOREM FOR A HOT GAS IN EQUILIBRIUM WITH RADIATION. V. S. Imshennik. Soviet Astron. AJ (English Transl.), 6: 426-7(Nov.-Dec. 1962).

It is shown that the conditions of the Zemplene theorem are fulfilled for an arbitrary ratio of radiation pressure to gas pressure, i.e., in a hot gas in equilibrium with radiation only compression shock waves are thermodynamically stable. (auth)

13189 RECOMBINATION LEVEL IN n-TYPE GERMANIUM IRRADIATED WITH ELECTRONS. L. G. Sharendo and L. S. Smirnov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 4: 1565-7(Feb. 1963).

The temperature dependence of the lifetime of excess carriers in n-type germanium, irradiated with fast electrons from a $Sr^{90}-Y^{90}$ source, was used to find the position of the recombination level of radiation defects. The level lies 0.26 ev above the valence band. The cross sections for capture by a recombination center are 2×10^{-16} cm^2 for electrons and 65×10^{-16} cm^2 for holes. Irradiation was carried out at room temperature. The position of the recombination level was not altered by annealing. (auth)

13190 ELECTRON PARAMAGNETIC RESONANCE OF Gd^{3+} IN CaF_2. V. M. Vinokurov, M. M. Zaripov, Yu. E. Pol'skii, V. G. Stepanov, G. K. Chirkin, and L. Ya. Shekun (Kazan' State Univ.). Soviet Phys.-Solid State (English Transl.), 4: 1637-9(Feb. 1963).

At frequencies from 8 to 51 kMc and in fields up to 23 kOe, the fine structure of the electron paramagnetic resonance spectrum of Gd^{3+} was investigated in artificial and natural CaF_2 crystals. The samples studied contained Gd^{3+} ions of two types. One ion type is described by a spin Hamiltonian with cubic symmetry. The spectrum of the other ion type is described by a Hamiltonian with tetragonal symmetry and the following constants: $g_{||} = g_{\perp} = 1.992 \pm 0.001$; $b_2^0 = 4.449 \pm 0.010$ kMc; $b_4^0 = 0.069 \pm 0.002$ kMc; $b_6^0 = 0.002 \pm 0.001$ kMc; $|b_4^4| = 0.437 \pm 0.005$ kMc; $b_6^4 = 0$. (auth)

13191 DETERMINATION OF AUGER EFFECT YIELDS FROM CHLORINE AND POTASSIUM K SHELLS FROM THE JUMP IN QUANTUM YIELD OF THE X-RAY PHOTOEFFECT OF A MASSIVE KCl CATHODE. M. A. Rumsh and V. N. Shchemelev (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 4: 1670(Feb. 1963).

A logarithmic plot of the quantum yield vs wavelength for the KCl photocathode was used to calculate the jumps in quantum emission at the Cl and K absorption edges. The Auger effect was found to be $w_a^K = 0.906 \pm 0.018$ and $w_a^{Cl} = 0.887 \pm 0.042$. (D.L.C.)

13192 ON OVERHAUSER EFFECT IN A LOW MAGNETIC FIELD. L. L. Buishvili and G. R. Khutsishvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 203-7(1962). (In Russian)

The case of a paramagnetic salt is considered when nuclei of paramagnetic atoms have spins. Overhauser effect is discussed both for splitting of the fine structure and for splitting caused by anisotropic hyperfine structure. According to Kittel and Abraham in the absence of an external magnetic field only alignment of nuclei is obtained at the saturation of the paramagnetic resonance. It is enough, however, to apply a low external field to the sample to obtain an appreciable polarization of the nuclei. The expression for the parameters f_1 and f_2 is obtained at the saturation of one of the components of fine or hyperfine structure. (auth)

13193 ACCELERATION OF LAMINAR FLOW OF CONDUCTING FLUID IN A FLAT TUBE WITH TRAVELLING MAGNETIC FIELD. N. M. Okhremenko. Zh. Prikl. Mekh. i Tekh. Fiz., No. 6, 18-21(Nov.-Dec. 1962). (In Russian)

Propagation of laminar flow was investigated by means of approximation equations of motion in which acceleration and viscosity are partially taken into account. The average flow rate and pressure drop were obtained using simplified assumptions (constant incoming rate, absence of surface effects, and negligible friction) and Laplace transforms. (R.V.J.)

13194 LOW-TEMPERATURE PHYSICS. Conduction Electrons — Superconductivity — Helium — Magnetism — Mössbauer Effect — Defects and Irradiation. Lectures Delivered at Les Houches During the 1961 Session of the Summer School of Theoretical Physics, University of Grenoble. C. DeWitt, B. Dreyfus, and P. G. de Gennes, eds. New York, Gordon and Breach, Science Publishers, 1962. 651p. $20.00.

Nine sets of edited lecture notes are presented, 5 in English and 4 in French. Separate abstracts have been prepared for 7. The two studies not abstracted separately investigate the properties of fine-grained antiferromagnetic materials and magnons. (T.F.H.)

13195 THE DYNAMICS OF CONDUCTION ELECTRONS. A. B. Pippard (Cambridge Univ., Eng.). p.1-146 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962.

Lectures are presented on: one- and three-dimensional motion of electrons; the Boltzmann transport equation; boundaries and size effects; effects of spatially varying electric fields; anomalous skin effects; interactions be-

tween electrons; electron dynamics in magnetic fields; galvanomagnetic effects; de Haas-van Alphen and related effects; acoustic attenuation; and cyclotron radiation. (T.F.H.)

13196 SUPERCONDUCTIVITY. M. Tinkham (Univ. of California, Berkeley). p.147-230 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962.

Lectures are presented on the properties of superconductors and on theories of superconductivity. Attention is given to the Bardeen-Cooper-Schrieffer theory in its derivative and alternative formulations. (T.F.H.)

13197 MAGNETISM AND SUPERCONDUCTIVITY. H. Suhl (Univ. of California, La Jolla). p.231-60 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962.

Magnetic phenomena (particularly, spin-paramagnetism) in superconductors are studied on the basis of the Bardeen-Cooper-Schrieffer theory of superconductivity. A review is made of attempts to explain the Knight shift well below the transition temperature; the superconducting-normal phase transition in some dilute alloys of superconductors with rare earths; the apparent magnetic ordering that occurs in some of these alloys; and a certain complementarity of superconductivity and localization of spin magnetic moment in alloys of superconducting and magnetic transition elements. Attention is given to uniform spin polarization in superconductors; attempts at explanations of the observed spin polarizations; and effects of impurities (particularly magnetic impurities) in superconductors. (T.F.H.)

13198 PROPERTIES OF HELIUM 3 AND 4. J. Beenakker (Kamerlingh Onnes Laboratorium, Leiden). p.261-305 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962.

A review is given of the similarities between He^3 and He^4; of the properties of liquid mixtures of these isotopes; superfluidity and flow properties of He II; rotation of the superfluid; properties of liquid He^3; and the transport properties of the excitation gas. (T.F.H.)

13199 MAGNETISM. A. Herpin (Centre d'Etudes Atomiques, Saclay, France). p.307-409 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962. (In French)

A review is presented of the theory of magnetism, beginning with an outline of the classical theory of magnetism and passing to studies of magnetic moments in atomic systems, the Heisenberg theory, superexchange, magnetic anisotropy, spin waves, antiferromagnetism, ferrimagnetism, and particular examples of magnetic structures. (T.F.H.)

13200 THE MÖSSBAUER EFFECT AND ITS APPLICATIONS TO A STUDY OF INTERNAL FIELDS. A. Abragam (Centre d'Etudes Nucléaires, Saclay, France). p.479-548 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962. (In French)

An outline is given of the theory of the Mössbauer effect. The effect of high-frequency vibration of the absorber or emitter of gamma radiation is studied. The use of the Mössbauer effect in studies of hyperfine structure is reviewed. Some properties of gamma radiation are summarized. The Mössbauer effect in Fe^{57} and Sn^{119} is discussed. The internal magnetic fields at nuclei in some ferromagnetic materials are tabulated. (T.F.H.)

13201 POINT DEFECTS AND IRRADIATION. J. Friedel (Service de Physique des Solides, Orsay, France). p.549-628 of "Low-Temperature Physics." New York, Gordon and Breach, Science Publishers, 1962. (In French)

The characteristics and production of point defects are summarized. The properties of point defects in metals, covalent solids, and ionic solids are reviewed. Radiation effects and annealing are studied. (T.F.H.)

13202 EXPLODING WIRES. VOLUME 2: Proceedings of the Second Conference on the Exploding Wire Phenomenon, Held at Boston, November 13-15, 1961, under the Sponsorship of the Geophysics Research Directorate, Air Force Cambridge Research Laboratories, Office of Aerospace Research, with the Cooperation of the Lowell Technological Institute Research Foundation. William G. Chace and Howard K. Moore, eds. New York, Plenum Press, 1962. 326p. $10.50.

Twenty-two papers are presented on the theory, shock wave production, instrumentation, and applications of exploding wires and foils. Separate abstracts were prepared for 18 of the papers; the remaining four were previously abstracted in NSA. (D.L.C.)

13203 FACTORS AFFECTING THE TIME TO BURST IN EXPLODING WIRES. Charles P. Nash and Clifford W. Olsen (Univ. of California, Davis). p.5-13 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962. (UCRL-6661-T)

Studies of Al, Cu, Ag, Au, Pd, and Pb wires are being conducted using a condenser bank of 11.4 kj maximum storage capacity. The order of increasing times to burst, which is not the same as the order of decreasing first-pulse energies, is Pb < Al < Au < Ag < Cu ≈ Pd. Results with numerous sets of Al samples of constant length but cross sections varying by a factor of about 25 show a linear relationship between the cross-sectional area A and the time to burst, at constant initial voltage. This linearity is shown to be consistent with a theoretical relationship, previously derived, which emphasizes the hydrodynamic energy per unit length and the radial expansion. (auth)

13204 RECENT CONTRIBUTIONS TO THE MACROSCOPIC ANALYSIS OF CONDUCTING ELECTROMECHANICAL SOLIDS. R. C. Geldmacher (New York Univ.). p.15-20 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

The behavior of conducting solids subjected to strong electric fields has been recently investigated analytically by both Haines and Geldmacher. The general formulation of the problem is presented and the solutions and results of the two authors are reviewed and discussed. Haines considers the transient current density distribution in cylindrical conductors and, using a combined discrete-continuum model, deduces the presence of an inverse skin effect. This effect may contribute to the breakup of wires subjected to short-duration, strong electric fields. Geldmacher considers the nonlinear problem resulting from electrothermal coupling through temperature-dependent electrical conductivity. Electromechanical body forces are also considered, and a breakup mechanism associated with the potential energy in the strain field is presented. The mechanical breakup mechanisms given by the two authors are entirely different, and it is suggested that actual breakup may be explained in terms of a combination of the two mechanisms. The solution involving electrothermal coupling should be of interest in cases where the melting breakup mode is dominant. (auth)

13205 LOWER-UPPER BOUNDS OF TEMPERATURES FOR WIRES EXPLODED IN A VACUUM. Carl A. Rouse (Univ. of California, Livermore). p.33-5 of "Exploding

Wires. Volume 2." New York, Plenum Press, 1962. (UCRL-6642-T)

Preliminary results of attempts to establish lower-upper bounds on exploding wire temperatures were completed. The numerical code used allows for hydrodynamic motion, radiation, ionization, and a time-dependent energy dump. Maximum blackbody temperatures for wires exploded in vacuum were found to be limited by the hydrodynamics, radiation, and ionization. The results are discussed. (auth)

13206 THE ELECTRICAL AND OPTICAL PROPERTIES OF RAPIDLY EXPLODED WIRES. Francis H. Webb, Jr. (Electro-Optical Systems, Inc., Pasadena, Calif.), Henry H. Hilton, Paul H. Levine, and Alvin V. Tollestrup. p.37-75 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

A series of experiments were performed on exploding small wires in times less than 10^{-7} sec with peak specific power levels between 5×10^{12} and 2×10^{14} w/mol. The processes occurring in the wire prior to and during the explosion process were studied. Simultaneous current and voltage oscillograms with nanosecond resolution, as well as Kerr cell photographs during the explosion, were obtained. In some cases the light intensity was measured. The materials studied can be classified into two phenomenological categories: Class I–low boiling point, low heat of vaporization. Class II–high boiling point, high heat of vaporization. The supersonic model is used to interpret the Class I behavior. In these cases the time required to place the vaporization energy into the material is small compared to that required for a sonic wave to traverse the wire. In the Class II materials the ablation model applies over a wide range of conditions. Here the sonic time is much shorter than the vaporization time. At energy densities greater than those corresponding to the end of melting, the apparent resistivity, as well as the energy coefficient of apparent resistivity, is significantly below handbook values for both the Class I and II materials. At high specific power levels these quantities appear to be functions of energy density alone over a wide range. Above the onset of vaporization the energy coefficient of resistivity is positive in Class I materials and negative in Class II materials. A classification scheme for wire explosions is suggested based primarily on specific power level. At high specific power levels for wires thin compared to the skin depth, where the kinetic pressure is larger than the magnetic pressure, ablation and supersonic conditions can occur. At ultrahigh specific power levels when the magnetic pressure dominates, a totally new regime of behavior is anticipated. (auth)

13207 ABOUT DISTANCES IN THE "CHARACTERISTIC PATTERN" OF EXPLODING WIRES. Heinrich Arnold and William M. Conn. p.77-86 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Striations in the characteristic patterns of exploded wires were recorded on glass slides held near the wires. The recordings were carried out under varying conditions but with constant electrical parameters of the circuit. The effects of slide distance from the wire and of air pressure on the number of striations per pattern were studied. Distribution functions are plotted for the distances between the striations, and possible explanations for the observed functions are discussed. (D.L.C.)

13208 EXPLODING WIRES AS A SOURCE OF X RAYS. I. M. Vitkovitsky, P. P. Bey, W. R. Faust, R. Fulper, Jr., G. E. Leavitt, and J. D. Shipman, Jr. (U. S. Naval Research Lab., Washington, D. C.). p.87-96 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Exploding wires emit x rays in vacuum, and a study was conducted of the characteristics of the x rays. Most of the x rays comes from the core of the explosion in the case of exploding-imploding cylindrical conductors and from the vicinity of the electrode in the case of wire explosion. The x-ray pulse is very short in duration (~20 nsec), its photon energy is ~5 kev, and the source is nonsymmetric about the explosion axis. (D.L.C.).

13209 CALORIMETRIC CALIBRATION OF THE ELECTRICAL ENERGY MEASUREMENT IN AN EXPLODING WIRE EXPERIMENT. D. H. Tsai and J. H. Park (National Bureau of Standards, Washington, D. C.). p.97-107 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

A discussion is presented on the requirements and the methods for measuring the current and voltage during the transient discharge of a capacitor bank being employed in an exploding wire experiment. A method is described for accurately calibrating the measured current, voltage, and electrical energy by comparing the calorimetric heating of a resistance element of essentially constant resistance with the electrical energy dissipated in the element. Results show that the accuracy of the energy measurement is about 1 to 2%. (auth)

13210 EFFECTS OF TRANSMISSION LINES IN APPLICATIONS OF EXPLODING WIRES. R. Carroll Maninger (General Precision, Inc., Sunnyvale, Calif.). p.109-26 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

In many applications, the lengths of connecting wires in exploding wire circuits may vary from a few inches to several feet. The connecting wires act as a transmission line with a characteristic impedance unique to the physical configuration of the circuit. If the time period of the wire explosion phenomenon is comparable to the transit time of electrical energy in the circuit, the efficiency of energy transfer to the wire is a function of the impedance mismatch between the circuit and the exploding wire. The effective impedance of the exploding wire is nonlinear; therefore, the impedance mismatch is also a function of time and the observed wire explosion phenomenon is affected by the circuit. The effects of transmission line behavior of circuits on current, voltage, and energy transfer are treated by finding the transient solutions of the transmission line equations. In general cases, the solutions are multiple summation series requiring considerable numerical computation for comparison with experimental results. Fortunately, in most applications the solutions are simple staircase functions. These predict circuit behavior within a few percent of observations. A number of rules of thumb were devised for use in estimating the degree of importance of transmission line effects in any given exploding wire circuit. (auth)

13211 MICROWAVE DOPPLER MEASUREMENTS OF THE IONIZATION FRONT IN CYLINDRICAL SHOCK WAVES FROM EXPLODING WIRES. Donald L. Jones and Roger M. Gallet (National Bureau of Standards, Boulder, Colo.). p.127-44 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Strong cylindrical shock waves from exploding wires were measured by microwave Doppler techniques. The results obtained simultaneously on two or three independent frequencies are in very good agreement and show that the ionization front is well defined. The Taylor-Lin similarity blast wave theory for the shock wave propagation is well verified over distances up to 6 or 7 cm under the present conditions. Systematic results for the determination of

shock wave energy and the efficiency for shock production in air over a range of pressures, wire diameters, and stored electrical energy are presented. Relative to optical methods used in the same problem the present technique is more sensitive and perhaps more precise. It is remarkable that very good reflections are still consistently obtained when the shock Mach number falls below 3 in air. From the calculated temperature and ionization in the shock front, the expected electron density should then be negligible. This effect is probably a result of the pre-excitation of the gas ahead of the shock front, caused by ultraviolet radiation from the wire explosion or from the advancing shock front itself. There is also a relatively weak precursor ionization, for which recent microwave absorption measurements have indicated electron densities of the order of 10^{11} cm^{-3} several centimeters ahead of the front. The good reflection at low Mach numbers permits one to show that the similarity theory is still valid until Mach number 4 or below, and permits one also to record the departure from this relation at larger radii. (auth)

13212 ELECTRICAL GENERATION OF IMPLODING SHOCK WAVES. R. S. Dennen and L. N. Wilson (Illinois Inst. of Tech., Chicago). p.145-57 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Imploding shock waves were generated by electrically exploding thin metallic films from the inner surface of glass cylinders. Preliminary measurements of the shock motion show close agreement with the predictions of constant-energy similarity analyses. In contrast to the exploding shock wave, the imploding wave appears to be inherently unstable. While irregularities in the surface of the wave are evident, particularly near the implosion center, Schlieren photographs showed a fairly symmetrical wave structure. (auth)

13213 BLAST WAVES PRODUCED BY EXPLODING WIRES. Koichi Oshima (Univ. of Southern California, Los Angeles). p.159-74 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Interferometric measurements of the blast waves produced by exploding wires in a shock chamber, which is evacuated to various low pressures, were conducted. The measured structure and propagation of the blast waves were systematically analyzed by Sakurai's second approximation for strong blast waves and by the quasi-similarity theory. A useful approximate analytical representation of the blast wave structure under the quasi-similarity theory is also introduced. (auth)

13214 EXPLODING-WIRE-DRIVEN SHOCK WAVES. G. L. Clark, J. J. Hickey, R. J. Kingsley, and R. F. Wuerker (Space Tech. Labs., Los Angeles). p.175-80 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

The explosion of fine silver wires and the formation of radial and circumferential shock waves were photographed with a streak camera. The results show two distinct regimes of exploding wire phenomena, depending on the capacitor voltage. At high voltage, a discharge channel forms almost immediately after the current break, while lower voltages produce longer dwells. The propagation of the shock waves is discussed. (D.L.C.)

13215 THE USE OF EXPLODING WIRES IN THE STUDY OF SMALL-SCALE UNDERWATER EXPLOSIONS. R. R. Buntzen (U. S. Naval Radiological Defense Lab., San Francisco). p.195-205 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Greater similarity in certain aspects to an underwater nuclear explosion is achieved by using a submerged exploding wire than with conventional chemical explosives. This is apparent in the high temperatures attained and in the lack of noncondensable explosion products in the exploding wire model. For the study of small-scale underwater detonations, a 6-μf, 25-kv, condenser bank produces an exploding wire yield equivalent to approximately 4.5×10^{-4} lb of TNT. The method used to determine the energy input to the submerged exploding wire is discussed. A general description of the underwater explosion event and energy partition analysis between bubble formation, shock wave, and thermal radiation is given. (auth)

13216 PRESSURE ENVIRONMENTS CREATED BY WIRES EXPLODED IN WATER. J. A. Kersavage (Chrysler Corp., Detroit). p.225-33 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Due to the increasing application of underwater electrical explosions to such fields as metal forming and sonar, the study of the pressures created by such discharges is steadily gaining importance. Results are presented of experiments in which a capacitor discharge circuit under various initial conditions was used to explode a 3-in. length of thin wire submerged in fresh water, and the resulting pressure at a particular range was recorded as a function of time using calibrated hydrophones and oscilloscopes. The entire pressure sequence of initial pulse and subsequent bubble pulses is discussed. The effect on the shape and amplitude of the initial pressure pulse of varying discharge circuit conditions such as initial capacitor voltage, total capacitance, and inductance is also presented. Initial capacitor voltages were varied up to 20 kv, and total stored energy in the bank was varied up to 300,000 joules. (auth)

13217 AN EXPLODING WIRE HYPERVELOCITY PROJECTOR. Victor E. Scherrer (Technical Operations, Inc., Burlington, Mass.). p.235-44 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Confined exploding wires are a very promising method of accelerating solid material particles to very high velocities. The very high energies and temperatures that can be generated by using high-power, fast-discharge capacitors are sufficient to generate particle velocities of 30 km/sec. The primary problem arises in transferring energy from hot propellant gases to the projectile in such a way that the projectile does not disintegrate. It appears that very high-temperature gases which accelerate the projectile over a relatively long distance, while absorbed radiation on the projectile rear surface both protects and accelerates the projectile, may be the best way of achieving the desired goal of accelerating projectiles to hypervelocities. (auth)

13218 HIGH-SPEED CINEMICROGRAPHIC STUDIES OF ELECTRICALLY EXPLODED METAL FILMS. L. Zernow, F. Wright, Jr., and G. Woffinden (Aerojet-General Corp., Downey, Calif.). p.245-62 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

Exploding metal films exhibit a striation phenomenon which has been previously reported. Studies of exploding films of aluminum on a glass substrate indicate that these striations are essentially perpendicular to the apparent current path and become visible early in the discharge as bright transverse regions from which aluminum is rapidly evaporated. More detailed studies of the formation of these striations were carried out with the cinemicroscopic technique. At 25 × magnification and at 1.2×10^6 frames/sec an unusual polarized structure can be seen forming during the current flow at the site of artificial scratches on the film. These structures appear essentially identical with those formed in the absence of artificial scratches. These obser-

vations are shown, and the effects of voltage and film thickness upon the striations are commented upon. (auth)

13219 EXPLODING FOILS—THE PRODUCTION OF PLANE SHOCK WAVES AND THE ACCELERATION OF THIN PLATES. D. V. Keller and J. R. Penning, Jr. (Boeing Co., Seattle). p.263-77 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

The electrical explosion of thin metal foils was used to induce shock waves in solids. The foil is either placed in direct contact with the solid, or is used to accelerate a thin-plate projectile to high velocity before it strikes a target. Pressures up to 10 kilobars are readily obtainable with the direct-contact method. Using the second method, 2-in. Mylar plates were accelerated to over 0.4 cm/μsec, resulting in pressures over 80 kilobars. The deviation from planarity of the shock waves produced by the two methods is approximately the same and is due to a slight nonsimultaneity in the foil explosion. Typically, a 2 in. square thin aluminum foil explodes simultaneously over its area within about 10^{-7} sec. This excellent simultaneity permits the acceleration of very thin projectile plates, with resultant short-duration pulses. 5-mil Mylar projectiles were used which produced 80-kilobar pulses with durations of only about 0.1 μsec. The dependence of the pressures and velocities obtained upon the circuit and foil-load assembly parameters is discussed. (auth)

13220 ACCELERATION OF THIN PLATES BY EXPLODING FOIL TECHNIQUES. A. H. Guenther, D. C. Wunsch, and T. D. Soapes (Air Force Special Weapons Center, Kirtland Air Force Base, N. Mex.). p.279-98 of "Exploding Wires. Volume 2." New York, Plenum Press, 1962.

A technique for the acceleration of thin plates to high velocities by exploding foils was developed. These plates, primarily Mylar and Lucite up to 3 in. by 3 in. and from a few mils to ¼ in. thick, are used to produce high-impulse, short-time loading of materials for the purpose of material dynamics at high pressures. Velocities up to 5×10^5 cm/sec were achieved. A brief description of equipment including the capacitor system, cameras, and backlighting, etc., is given, as well as a more detailed description of the construction of the transducer and its characteristics. Methods of velocity determination are described. High-speed photographs of these high-velocity plates are presented. (auth)

13221 THE MÖSSBAUER EFFECT. Proceedings of the Second International Conference on the Mössbauer Effect Held at Saclay, France on September 13-15, 1961. D. M. J. Compton and A. H. Schoen, eds. New York, John Wiley & Sons, Inc., 1962. 328p. $16.50.

Forty-nine papers are included; separate abstracts have been prepared for 43. Six papers were previously abstracted in NSA. Several notes and discussions are also included. (T.F.H.)

13222 SOME ASPECTS OF GAMMA EMISSION. Joachim Petzold (Universität, Heidelberg). p.2-8 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Mathematical characteristics of Mössbauer absorption and emission are outlined. (T.F.H.)

13223 COHERENCE EFFECTS IN MÖSSBAUER RADIATION. C. Tzara (Centre d'Études Nucléaires, Saclay, France). p.14-16 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Fundamental interference and coherence effects in the Mössbauer effect are outlined. (T.F.H.)

13224 DESIGNS FOR CONSTANT VELOCITY AND CONSTANT ACCELERATION DRIVES. A. H. Schoen (General Dynamics Scientific Research Lab., San Diego, Calif.). p.40-8 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A proposed design for a unidirectional constant velocity drive, based on a four-bar linkage, is discussed. The drive is expected to provide velocity constant within ~±0.3% for 60 to 70° of each cycle. A constant acceleration drive, using a crank and connecting rod assembly, is described. It is designed to provide velocity, both to and fro, which varies linearly with time with an error of less than 0.1% of the maximum velocity. An equivalent circular cam arrangement and a suggestion related to the design of constant velocity cams are mentioned. Functions suitable for harmonic synthesis of flat waveforms are defined. (auth)

13225 TRANSDUCER FOR MÖSSBAUER EXPERIMENTS. F. J. Lynch and J. B. Baumgardner (Argonne National Lab., Ill.). p.54-7 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A transducer is described that produces a velocity that varies linearly with time, such that equal times are spent in equal velocity intervals in the regions of interest. The Mössbauer spectra produced in this apparatus are displayed directly on a multi-channel analyzer. (T.F.H.)

13226 DETECTION AND MEASUREMENT OF SMALL FREQUENCY SHIFTS. R. V. Pound (Harvard Univ., Cambridge). p.58-62 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The mechanics of detection and measurement of very small frequency shifts in the Mössbauer effect are discussed. The statistical aspects of studies of these frequency shifts are outlined. (T.F.H.)

13227 FREQUENCY MODULATED MÖSSBAUER EFFECT. R. Brout (Los Alamos Scientific Lab., N. Mex. and Cornell Univ., Ithaca, N. Y.). p.66-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A classical analysis is presented of a Mössbauer experiment in which the absorber is in uniform motion relative to the emitter. The gamma line is assumed to have no hyperfine structure. Frequency shifts much greater than and much less than the Doppler shift and the natural width of the line are studied. (T.F.H.)

13228 EXPERIMENTAL DETERMINATION OF LATTICE PROPERTIES. A. J. F. Boyle (Univ. of Manchester, Eng.). p.78-84 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The value of the use of the Mössbauer effect in studies of crystal properties (mean-square displacement, lattice specific heat, normal modes of phonon spectrum, impurity modes, and diffusion) is discussed. It is concluded that very little useful information can be obtained from such studies. (T.F.H.)

13229 TEMPERATURE DEPENDENCE OF THE MÖSSBAUER EFFECT IN METALLIC Fe-57. S. S. Hanna, R. S. Preston, and J. Heberle (Argonne National Lab., Ill.). p.85-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer effect is studied in Fe^{57} in metallic Fe above and below the Curie point (0 to 1300°K), and the effects of temperature are detailed. (T.F.H.)

13230 MÖSSBAUER EFFECT OF Fe-57 IN VARIOUS COMPOUNDS AT DIFFERENT TEMPERATURES. W. Kerler and W. Neuwirth (Universität, Heidelberg).

p.90-6 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer effect is measured for Fe^{57} in Fe, Fe compounds, and stainless steel, at −150 to +150°C. (T.F.H.)

13231 SECOND ORDER VELOCITY SHIFT OF THE MÖSSBAUER RESONANCE. A. A. Maradudin, P. A. Flinn, and S. L. Ruby (Westinghouse Electric Corp., Forest Hills, Penna.). p.97-101 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The effects of impurity-host force constants and mass ratios on the values of $\langle v^2 \rangle$ for the impurity atoms in lattices are studied. These effects are determined at very high and very low temperatures, as regards their influence on the Mössbauer effect. Examples are discussed of Fe in Be, Cu, Fe, and stainless steel. (T.F.H.)

13232 TEMPERATURE EFFECTS USING Fe-57 IN IRON AND IN COPPER. N. A. Dyson (Univ. of Birmingham, Eng.). p.102-4 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer effect is measured at 20 to 850°C, for sources composed of Fe^{57} in Cu and Fe respectively, and absorbers of stainless steel and natural Fe respectively. (T.F.H.)

13233 MÖSSBAUER EFFECT IN FERROCENE AND RELATED COMPOUNDS. R. H. Herber (Rutgers State Univ., New Brunswick, N. J.) and G. K. Wertheim. p.105-11 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Mössbauer absorption by Fe in ferrocene $(Fe^{2+}(C_5H_5)_2)$ and in ferricinium bromide $(Fe^{3+}(C_5H_5)_2Br)$ is studied at 20 to 295°K. Stainless steel and cobalticinium tetraphenyl borate $(Co(C_5H_5)_2B(C_6H_5)_4)$ are used as sources. It is found that the bonding electrons increase the charge density at the nucleus by an amount $4s^{0.3}$, indicating that the Fe bonds in these compounds are strongly covalent. The isomer shifts and quadrupole coupling constants are measured for ferrocene and ferricinium bromide. (T.F.H.)

13234 MÖSSBAUER EFFECT WITH Fe-57 IN GRAPHITE. H. Pollak, M. de Coster, and S. Amelinckx (Centre d'Etudes de l'Energie Nucleaire, Mol, Belgium). p.112-15 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer spectra of Fe^{57} in a graphite source are measured at 20 to 470°C, using a stainless steel absorber. Measurements are made parallel and perpendicular to the c axis of the crystal. (T.F.H.)

13235 THE HYPERFINE STRUCTURE OF Fe-57 IN VARIOUS OXIDES. G. K. Wertheim and D. N. E. Buchanan (Bell Telephone Labs., Inc., Murray Hill, N. J.). p.130-42 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The isomer shifts and quadrupole coupling constants in the Mössbauer spectra of divalent and trivalent Fe^{57} in matrices of CoO, MgO, Al_2O_3, and Fe_2O_3 (with respect to 310 stainless steel) are measured at 78 to 298°K. The effect of the type of lattice position occupied by the Fe^{57} (interstitial or substitutional) on the spectra is discussed. (T.F.H.)

13236 HYPERFINE FIELDS IN ALLOYS OF IRON. C. E. Johnson, M. S. Ridout, and T. E. Cranshaw (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.142-5 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The hyperfine structure of the Fe^{57} spectrum in F_2Ti, Fe_2Zr, Fe−Co, Fe−Al, Fe−Ni, Fe−V, Fe−Cr, and Fe−Mn alloys is measured. It is found that the hyperfine field at the Fe^{57} nucleus can be expressed as a linear combination of terms involving the moment on the Fe atom and the saturation moment. (T.F.H.)

13237 LOCAL MAGNETIC FIELDS IN Fe−Al ALLOYS. P. A. Flinn and S. L. Ruby (Westinghouse Electric Corp., Forest Hills, Penna.). p.146-7 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A model is presented in which the local magnetic field at the Fe atom in an Al−Fe alloy is assumed to vary smoothly from 0 to 330 kOe as the number of Al nearest neighbors varies from 8 to 0. This model is used to interpret the Mössbauer spectra of Fe^{57} in Al−Fe alloys containing up to 28% Al. (T.F.H.)

13238 A MÖSSBAUER PARITY EXPERIMENT. H. H. F. Wegener, F. E. Obenshain, and M. E. Rose (Oak Ridge National Lab., Tenn.). p.156-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The beta-gamma cascade from the ground state of Co^{61} to the first excited state of Ni^{61} to the ground state of Ni^{61} is studied using the Mössbauer effect. The Co^{61} is incorporated in a metallic Ni source, which is driven at the desired frequency. The relations between the magnetic moments of the nuclear states involved, the magnetic hyperfine structures of the levels, the gamma spectra, and the parity considerations are explored. (T.F.H.)

13239 QUADRUPOLE MOMENT OF Fe-57m. J. Gastebois (Centre d'Etudes Nucléaires, Saclay, France). p.160-2 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A Co^{57} Mössbauer source plated on stainless steel is used with a Fe_2O_3 absorber at 90°K to study the quadrupole interaction of the first excited state of Fe^{57} at this temperature. It is found that the magnetic field is parallel to the crystal axis, that the quadrupole moment is positive, and that $e^2qQ/4 = +(0.0222 \pm 0.0032)$ cm/sec at 90°K. (T.F.H.)

13240 INTERACTION BETWEEN Fe-57 AND ITS CRYSTALLINE SURROUNDINGS. L. G. Lang, S. DeBenedetti, and R. I. Ingalls (Carnegie Inst. of Tech., Pittsburgh, Penna.). p.168-71 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The quadrupole splittings of the Mössbauer absorption patterns of Fe-57 in $FeSO_4 \cdot 7H_2O$, $FeCl_2 \cdot 4H_2O$, and $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$ are measured as a function of temperature. Low-temperature limiting values of the splittings are found to be 0.350, 0.315, and 0.277 cm/sec (all ±0.005 cm/sec) respectively. The temperature dependence is interpreted in terms of the temperature-dependent occupation probabilities of the triplet states of the ferrous d electron. Characteristic temperatures of 800, 1000, and 380°K respectively are assigned. A computation indicates that the antishielding factor for the field gradient caused by the ferrous d electron is $\gamma = 0.42$. The magnitude of the quadrupole moment of the excited state of Fe-57 is estimated to be 0.18 barn. (auth)

13241 RECOILLESS RESONANT ABSORPTION IN NUCLEAR TRANSITIONS OF THE RARE EARTHS. R. Cohen, U. Hauser, and R. L. Mössbauer (California Inst. of Tech., Pasadena). p.172-6 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Crystalline-field and hyperfine level splitting in rare earths in the paramagnetic region is discussed. The Mössbauer effect is used to measure the splitting in Tm^{169} as an example. Sources of Er metal and Er_2O_3 (Er^{169} beta-decays to Tm^{169}) are used, along with absorbers of Tm metal and

Tm_2O_3, in all four possible metal–oxide combinations. (T.F.H.)

13242 MÖSSBAUER EFFECT EXPERIMENTS IN JERUSALEM. R. Bauminger, S. G. Cohen, A. Marinov, and S. Ofer (Hebrew Univ., Jerusalem). p.177-81 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer spectra of Dy^{160} (87 kev) and Dy^{161} (26 kev) in dysprosium iron garnet are measured at 85 and 300°K, using sources of Tb (the parent of Dy^{160} and Dy^{161}) diffused in Cu. The hyperfine interactions and chemical shifts, as well as other crystalline properties, are calculated from these spectra. (T.F.H.)

13243 HYPERFINE FIELDS IN DYSPROSIUM METAL. A. J. F. Boyle, D. St. P. Bunbury, C. Edwards, and H. E. Hall (Univ. of Manchester, Eng.). p.182-4 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The recoilless 26-kev gamma transition in Dy^{161} is used to study the hyperfine fields in Dy metal. A source composed of Dy^{161} in Mg is used, and a Dy metal absorber. The ratio of the magnetic moments of the 26-kev and ground states is also determined. (T.F.H.)

13244 HYPERFINE SPLITTING OF GAMMA RAYS FROM RARE EARTH NUCLIDES. P. Kienle (Technische Hochschule, Munich), M. Kalvius, F. Stanek, F. Wagner, H. Eicher, and W. Wiedemann. p.185-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer effect is studied for the nuclides Yb^{170}, Er^{166}, and Tm^{169}, using as sources Tm, Ho_2O_3, and Er_2O_3 respectively, and using as absorbers Yb_2O_3, Er_2O_3, and Tm_2O_3 respectively. The measurements are carried out at 20, 20, and 300°K respectively. The purpose of the investigation is to analyze the effect of the hyperfine interaction on nuclear levels of the rare earth ions in the oxide crystals. (T.F.H.)

13245 INTERNAL FIELDS IN TIN AND TIN ALLOYS. Luise Meyer-Schuetzmeister (Argonne National Lab., Ill.). p.190-8 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Analyses of Sn and Sn alloys by means of the Mössbauer effect are described. Sn^{119} Mössbauer spectra obtained using SnO_2, Sn metal, Sn metal, and Sn metal respectively as sources and Sn metal, Sn metal, SnGd, and Mn_3Sn respectively as absorbers are described, for the temperature range 4 to 414°K. Magnetic fields at Fe, Co, Ni, Mn, and Gd nuclei in ferromagnetic binary alloys with Fe, Co, Ni, Sn, and Au are tabulated. The relation between the Mössbauer spectral shapes and the internal magnetic fields is studied. (T.F.H.)

13246 A MÖSSBAUER EFFECT LOW TEMPERATURE THERMOMETER. R. Dean Taylor (Los Alamos Scientific Lab., N. Mex.). p.203-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A thermometry system is described that comprises a Mössbauer source (Co^{57} diffused in Fe) at the temperature to be measured (below 4°K) and an absorber consisting of potassium ferrocyanide or Fe diffused in Ti. The temperature difference is calculated on the assumption that the decay scheme of Co^{57} at the low temperature is known and that there are no depolarization effects in the decay. Then the temperature shift of the Mössbauer spectra can be used as a measure of the source-absorber temperature difference. (T.F.H.)

13247 THE MÖSSBAUER EFFECT IN SUPERCONDUCTING AND NORMAL TIN. W. H. Wiedemann (Bayerischen Akademie der Wissenschaften, Munich), P. Kienle, and F. Pobell. p.210-15 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The temperature dependence of the Sn^{119} Mössbauer spectra in Sn below 77°K is measured, as a means of detecting and determining a possible change in the Debye-Waller factor ($\underline{f}$) across the normal-superconducting transition temperature in Sn (T_c = 3.73°K). The Mössbauer spectra yield $\underline{f}$(4.2°K) = 0.60. The temperature dependence of $\underline{f}$ is calculated from 0 to 20°K in terms of the Debye temperature (θ_D), and the experimental data can be fit by using θ_D = 155°K. The change ($\Delta\underline{f}/\underline{f}$) in $\underline{f}$ across T_c is measured as 0.4%. (T.F.H.)

13248 RECENT DEVELOPMENTS IN THE MEASUREMENT OF SMALL SHIFTS. R. V. Pound (Harvard Univ., Cambridge, Mass.). p.217-24 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Shifts in Mössbauer spectra resulting from differences in gravitational potential, electrostatic potential, atmospheric pressure, and temperature between the gamma source and resonant absorber are discussed. Techniques for measuring these and other very small shifts are outlined. (T.F.H.)

13249 A MEASUREMENT OF THE "RED SHIFT" IN AN ACCELERATED SYSTEM. H. J. Hay (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.225-8 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A Mössbauer-type measurement of the relativistic time dilation is reported. A Fe^{57} source is mounted near the axis of rotation of a turntable, and a resonant absorber is placed in a ring around the periphery of the turntable. Rotational speeds up to 500 rps are used. It is found that the frequency shift in the absorber spectrum is proportional to the square of the rotational frequency, as is predicted by special relativity, and that the magnitude of the shift is in agreement with a special-relativistic calculation. (T.F.H.)

13250 MEASUREMENT OF THE FREQUENCY SHIFT OF GAMMA RAYS IN ACCELERATED SYSTEMS USING THE MÖSSBAUER EFFECT. H. E. Boemmel (Bell Telephone Labs., Murray Hill, N. J.). p.229-32 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The shift in the Mössbauer spectrum of the 14.4-kev line of Fe^{57} is used to study the relativistic shift of the frequency of gamma radiation. The source and absorber are mounted on faces of nearly identical quartz crystals, and are vibrated exactly in phase at 1 to 5 Mc, along the line joining them. There is no relative motion of the source and absorber, and thus no Doppler broadening. The observed effects of vibration frequency and source-absorber distance on the frequency shift are as predicted by relativity theory. (T.F.H.)

13251 INTERFERENCE BETWEEN RAYLEIGH AND NUCLEAR RESONANCE SCATTERING. P. J. Black, D. E. Evans, and D. A. O'Connor (Univ. of Birmingham, Eng.). p.233-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A calculation is shown of the interference between Rayleigh and Mössbauer scattering from thick scatterers. The scattering is assumed to be centered in a small angular range about a Bragg peak. Experimental results using Fe scatterers and Fe^{57} gamma radiation are compared with the calculated distributions, for scattering angles of 20 to 90°. (T.F.H.)

13252 RECOIL-FREE RESONANT AND NONRESONANT SCATTERING FROM Fe-57. J. K. Major (Tech-

nische Hochschule, Munich). p.242-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The recoil-free nuclear resonant scattering of 14-kev Fe^{57} gamma rays from stainless steel is measured as a function of source velocity, absorber thickness, scatterer thickness, and scattering angle. The line widths of the transmitted and scattered radiation are equal within experimental error, but larger than predicted from the natural line width. Measurement of the resonant absorption as a function of absorber thickness yields the Debye-Waller factor of the source. The resonant scattering is independent of scatterer thickness, confirming that the scatterers used are much thicker than the mean free path for resonant scattering. The observed angular distribution of the resonant scattering agrees with theory, neglecting multiple scattering, interference, and line width effects, and supports the assumption that the recoil-free fraction is independent of angle and proportional to the square of the Debye-Waller factor of the scatterer. Agreement is less satisfactory, especially at small angles, in a second experiment where the incident and emergent angles are equal, but the discrepancies may be related to interference effects at Bragg angles. Recoil-free atomic nonresonant scattering is observed from copper, aluminum, graphite, and glass, but not from paraffin, polyethylene, polyvinyl chloride, or polymethyl methacrylate. The line width of the recoil-free nonresonant scattering from glass appears to be the same as for resonant scattering. (auth)

13253 TOTAL REFLECTION OF GAMMA RAYS OVER THE REGION OF NUCLEAR ANOMALOUS DISPERSION IN Fe-57. S. Bernstein and E. C. Campbell (Oak Ridge National Lab., Tenn.). p.250-3 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

An apparatus is described that consists of a small Mössbauer source (Fe^{57} plated on stainless steel), which is blocked from shining directly on the gamma detector by a Pb stop, but which can shine reflected light on the detector via a Fe^{57}-enriched mirror. The mirror is situated halfway between the source and detector, such that the incident and reflected angles (θ) are equal. The reflected intensity is measured as a function of θ from 0 to 9 mradian, and of source velocity from 0 to 8 cm/sec. The reflectivity of the mirror is calculated as a function of energy (near a given resonance) for several values of θ, and is found to approach 100% under suitable conditions. (T.F.H.)

13254 NUCLEAR APPLICATIONS OF ISOMERIC SHIFTS. D. A. Shirley (Univ. of California, Berkeley). p.255-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A theoretical analysis is made of the properties of the isomer shift in Au^{197}. This shift is compared with those in Sn^{119} and Fe^{57}. Shifts are tabulated for Au^{197} in Au, Pt, Fe, Co, and Ni host lattices. (T.F.H.)

13255 CALIBRATION OF THE ISOMER SHIFT USING "ALMOST-FREE" ATOMS. V. Jaccarino and G. K. Wertheim (Bell Telephone Labs., Inc., Murray Hill, N. J.). p.260-3 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

It is proposed that the isomer shift in Fe^{57} be calibrated by incorporating Fe^{57} or Co^{57} into a solid rare-gas matrix (e.g., Ar), using the so-called matrix isolation method. It is conjectured that Fe in this type of matrix should behave nearly like the free Fe atoms. The systematics of the Fe isomer shifts are summarized graphically. (T.F.H.)

13256 ISOMER SHIFTS OF Sn-119. O. C. Kistner (Brookhaven National Lab., Upton, N. Y.), V. Jaccarino, and L. R. Walker. p.264-6 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The isomer-shift systematics of the Sn^{119} Mössbauer spectra in Sn(II) and (IV) compounds and alloys are presented schematically, and the results are interpreted in terms of the properties and interactions of the 5s and 5p electron shells. The data imply that the 5p electrons do not appreciably shield the 5s electrons. (T.F.H.)

13257 THE MEAN SQUARE DEFORMATION OF THE GROUND AND FIRST EXCITED STATES OF Sn-119. A. J. F. Boyle, D. St. P. Bunbury, and C. Edwards (Univ. of Manchester, Eng.). p.267-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer spectra of Sn^{119} in tetragonal and orthorhombic SnO are determined, and are used to calculate the nuclear deformation parameters and quadrupole moment of Sn^{119}. The calculated values are compared with corresponding data for Sn^{118} and Sn^{120}. (T.F.H.)

13258 A WORD OF CAUTION ON THE USE OF BERYLLIUM WINDOWS. O. C. Kistner and J. B. Swan (Brookhaven National Lab., Upton, N. Y.). p.270 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

It is cautioned that Be windows and backings may contain Fe as an impurity, and may thus contribute parasitic counts in Fe^{57} Mössbauer measurements. A typical Mössbauer spectrum of Fe-containing Be is shown. This spectrum contains structure at about −1 to +1 mm/sec, and contributes about 4 to 6% to the absorption. (T.F.H.)

13259 MÖSSBAUER EFFECT IN METAL-ORGANIC COMPOUNDS. U. Zahn (Universität, Munich), P. Kienle, and H. Eicher. p.271-3 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer spectra of Fe^{57} are determined in ferrocene ($Fe(C_5H_5)_2$), ferricinium ($Fe(C_5H_5)_2^+$), $Fe_2(CO)_9$, and $[Fe(C_5H_5)(CO)_2]_2$. The quadrupole splittings and isomeric shifts are measured in these compounds, using a Fe^{57} source dispersed in stainless steel. The data for ferrocene and (ferricinium)(BF_4) are analyzed in order to determine the structure of the electron orbitals in these two compounds. (T.F.H.)

13260 PHASE MODULATION OF GAMMA RAYS. L. Grodzins and E. A. Phillips (Massachusetts Inst. of Tech., Cambridge). p.275-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A Mössbauer experiment is described using a Fe^{57}-in-Fe source and A Fe absorber that is driven by a constant-velocity cam. Between the source and absorber is interposed a wheel having n fan-like wedge-shaped blades, such that successive photons leaving the source must traverse increasing thicknesses of blade material, as a given blade sweeps through the beam. Thus the phase of the electromagnetic signal reaching the absorber is modulated n times per revolution of the wheel. The strength of this phase modulation can be used as a means for determining the index of refraction of the blade material. Results are given for lucite (1.29×10^{-6}) and Al (2.50×10^{-6}) blades as examples. (T.F.H.)

13261 MÖSSBAUER EFFECT OF Fe-57 IN PYROGRAPHITE: SOME PRELIMINARY RESULTS. P. Craig, N. Erickson, D. Nagle, and R. Taylor (Los Alamos Scientific Lab., N. Mex.). p.280 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

Mössbauer spectra of Fe^{57} in pyrolytic graphite at 4, 80, and 300°K are measured, both parallel and perpendicular to the graphite c axis. The sources of Fe^{57} used are intercalated $CoCl_2$ and Co atoms. (T.F.H.)

13262 MÖSSBAUER EFFECT IN HEMIN. Ulrich Gonser (Atomics International, Canoga Park, Calif.). p.281-2 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

A measurement of the Mössbauer spectrum of hemin at 80°K is shown. A shift on the order of 0.01 cm/sec is observed, relative to a Fe^{57} source in Cu. (T.F.H.)

13263 THE RESONANCE ABSORPTION OF THE GAMMA EMISSION FROM Fe-57 IN n AND p TYPE SILICON AND GERMANIUM. M. de Coster, H. Pollak, and S. Amelinckx (Centre d'Études de l'Énergie Nucléaire, Mol, Belgium). p.289-97 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

$CoCl_2$ is diffused into heavily doped Si and Ge samples, and the Mössbauer spectra of Fe^{57} (from β decay of Co^{57}) are measured in these samples at room temperature. The heavy doping is necessary to preserve the Fermi level, and hence the n or p nature, of the sample. Stainless steel absorbers are used. The isomeric shifts between the n- and p-type materials are interpreted in terms of the different charge states of the Fe atoms in these materials. (T.F.H.)

13264 MÖSSBAUER EFFECT IN AMORPHOUS SUBSTANCES. H. Pollak, M. de Coster, and S. Amelinckx (Centre d'Études de l'Énergie Nucléaire, Mol, Belgium). p.298-9 of "The Mössbauer Effect." New York, John Wiley & Sons, Inc., 1962.

The Mössbauer spectra of Fe^{57} diffused in fused quartz and pyrex glass are measured, using a stainless steel absorber. A shift of 0.4 mm/sec is observed, with a large line width. (T.F.H.)

13265 SOVIET SCIENCE OF INTERSTELLAR SPACE. S. Pikelner. Translated from the Russian by Mary Zirin. New York, Philosophical Library, 1963. 230p. $7.50.

Observations and speculations resulting from Russian research on planetary nebulae, diffuse nebulae, interstellar gas, magnetic fields, and evolution of galactic matter are contained. (D.C.W.)

13266 A VARIATIONAL CALCULATION OF THE REPULSIVE INTERACTION ENERGY BETWEEN TWO HELIUM ATOMS USING UNITED ATOM WAVE FUNCTIONS. Robert Vance Miller. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1962. 98p.

The total energy of interaction between two helium atoms was calculated for internuclear separations R = 0.50, 0.75, and 1.00 au (0.529 Å) with united atom wave functions by means of the variational method. Slater type orbitals were used in Slater determinants to form the antisymmetric wave functions for $^1\Sigma_g^+$ states. The equivalent of one variational parameter was used for each type of electron orbital. The expectation value of the Hamiltonian was minimized for the $(1s^22s^2)$, $(1s^22p\sigma^2)$, and $(1s^23d\sigma^2)$ single configurations. The correlation diagram for states of homonuclear diatomic molecules indicates that the energy level for the $(1s^22s^2)$ configuration corresponding to the ground state of the united atom beryllium lies lower at small separations, while the $(1s^22p\sigma^2)$ configuration gives lower energies at large separations. The separation R_c at which the energy levels for the two configuration cross was determined with the single configuration wave functions. The procedure indicated that for values of the separation less than $R_c = 0.56$ au the wave function may be said to have a predominantly atomic character in contrast to the molecular character at large separations, which is well represented by two center wave functions. A linear combination of $(1s^22s^2)$ and $(1s^22p\sigma^2)$ wave functions gave an improvement of 1.1 ev in the calculated value of the energy for an internuclear separation of 0.50 au. Much smaller improvements were obtained at larger separations. A linear combination of wave functions for the $(1s^22s^2)$ and $(1s3d\sigma2s^2, {}^1\Sigma_g^+)$ configurations resulted in total energies which were 6 to 8 ev lower than those for the single configuration $(1s^22s^2)$ at the internuclear separations. The improvement obtained as a result of the inclusion of a $3d\sigma$ orbital indicates the importance of the higher order multipole moments associated with the potential energy of the electrons in the field of the nuclei in any study of the He-He interaction at small separations. It was found that the united atom treatment of the He-He interaction is preferred over the two-center method for small separations up to at least 0.6 au. (P.C.H.)

13267 THE HYDROGEN RADIATION SPECTRUM IN GASEOUS CONFIGURATIONS. Eugene Raymond Capriotti. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 143p.

Emission in Balmer and Paschen lines from various gaseous configurations are described. The configurations considered are spherical shells with various ratios of radii. The configurations are assumed to be at a constant electron temperature throughout and to have a uniform distribution of hydrogen atoms in the 2 p-state. Only radiative transitions are considered and upward transitions are assumed to occur only from the 1 s level and the 2 p level. Furthermore, the configurations are assumed to be optically thick in the Lyman lines. Photons are assumed to be emitted with Doppler profiles and absorbing atoms are assumed to have a Maxwellian velocity distribution. Calculations of the emissions in the Balmer and Paschen lines are carried out for a range of total depths in H_α along the diameters of the configuration and for two electron temperatures, $T_e = 10^{4\circ}K$ and $T_e = 2 \times 10^{4\circ}K$. Finally, the results of the calculations carried out were compared to previous theoretical results and to observational results. (Dissertation Abstr., 23: No. 6, Dec. 1962)

13268 IMPROVEMENTS IN OR RELATING TO ION SOURCES. James Harry Freeman (to United Kingdom Atomic Energy Authority). British Patent 916,703. Jan. 23, 1963. Filed May 18, 1960.

An arc chamber was described having a slit in the wall and a directly heated cathode arranged within the arc chamber in spaced parallel relation with the slit. The region between cathode and wall was free of any interposed grids so that when a potential was applied between the chamber and the cathode an arc discharge was produced within the chamber. A magnetic field was applied parallel to the cathode to constrain the discharge. (C.E.S.)

Astrophysics and Cosmology

13269 EVOLUTION OF A STAR WITH INTERMEDIATE MASS AFTER HYDROGEN BURNING. [PART] I. Chushiro Hayashi, Minoru Nishida, and Daiichiro Sugimoto (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1233-52(June 1962). (In English)

The evolution of a population I star of 4 $M_\odot$, after the formation of a dehydrogenized core and a hydrogen burning shell, is calculated up to the stage when helium has almost burnt out in the central region. This course of the evolution is divided into three phases. In the first phase, the star has a hydrogen-burning shell and an isothermal core, and the star stays near the main sequence for 2.1×10^6 years, until the mass fraction of the core grows to 0.120 beyond which there exists no solution with an isothermal core. In the second phase, the core of the star contracts rapidly releasing gravitational energy while the envelope expands.

The central temperature increases and the star comes to the red giant region in 1.1×10^6 years before helium begins to burn. In this course electrons do not become degenerate and 4 $M_\odot$ is found to be near a critical stellar mass devoid of the formation of a degenerate isothermal core. Finally, in the phase of helium burning, the core expands and the envelope shrinks slowly until the helium content in the central region decreases to 0.3. Afterwards the envelope expands again. The lifetime of the helium burning phase is 2.1×10^7 years and the star spends half of this time as an A-type giant near the turning point. Effects of uncertainties in nuclear energy generation rates, opacities, and chemical compositions on the structure of this A-type giant are examined. Even if these uncertainties are taken into account, a separate group of A-type giants in the Herzsprung-Russell diagram of NGC 458 can be identified with the helium-burning phase. The observed number of these stars is consistent with the calculated lifetime. (auth)

13270 ZIRCONIUM AND HAFNIUM IN STONE METEORITES. W. D. Ehmann and J. L. Setser (Univ. of Kentucky, Lexington). Science, 139: 594-5(Feb. 15, 1963).

The abundances of zirconium and hafnium in stone meteorites were determined by neutron activation analysis. Specific radiochemical separations were used to obtain individual zirconium and hafnium samples of high radiochemical purity. The average abundance of zirconium in chondrites for six analyses was 35 ppm; of hafnium, 0.19 ppm. The hafnium abundances are in good general agreement with the predictions of current theories of nucleosynthesis. (auth)

13271 RADIATION FROM HYDROGEN ATOMS EXCITED BY THE SYNCHROTRON RADIATION OF RELATIVISTIC ELECTRONS. I. M. Gordon and L. D. Pichakhchi. Soviet Astron. AJ (English Transl.), 5: 63-5(July-Aug. 1961).

It is shown that the emission spectrum of T Tauri stars with anomalous continuous radiation in the ultraviolet can be explained by assuming that it is a negative absorption spectrum of hydrogen excited by synchrotron radiation of great intensity in a small part of the star's atmosphere—in its active zone. A method was also proposed for the determination of the spectrum of synchrotron radiation from the observed hydrogen emission spectrum. The intensity in the infrared part of the spectrum was determined from the broadening of the higher terms of the Balmer series that form the quasicontinuum, while the intensity in the ultraviolet was determined from hydrogen ionization. In the present study the distribution of hydrogen atoms among the excited levels in the field of such radiation is calculated using an electronic computer. The calculations show that the Balmer lines will in fact be observed in emission due to induced transitions, i.e., as a sequence of negative absorption lines. The considerable overpopulation of the upper levels is responsible for the small Balmer decrement and the appearance of anomalous emission in the ultraviolet and also for the increase in intensity of the latter when approaching the Balmer discontinuity. Thus the theory of the excitation of the emission spectrum of T Tauri stars is confirmed quantitatively. (auth)

13272 CORPUSCULAR STREAMS AND THE SOLAR CORONA ABOVE ACTIVE REGIONS. É. R. Mustel' (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 287-98(Nov.-Dec. 1961).

Evidence is given that the active regions themselves are the sources of M-corpuscles. The average distance $\overline{\Delta L}$ between two neighboring "central" plages is computed (the number of plages is about 500). It is found that $\overline{\Delta L}$ is equal to 6-7 days. This gives not only a qualitative but also a quantitative explanation of all the principal characteristics M_1, M_2, m_1, m_2 of the statistical curves obtained. A more complete summary of all statistical curves is given that shows that the only stable feature of these curves is the right-hand maximum M_2. Severe arguments bared on the characteristics of individual M-disturbances are presented. The article also deals with the problem of which elements of an active region are responsible for the production of corpuscular streams. Several arguments show that sun-spots and quiescent filaments do not play an essential role. Curves are obtained for all plages of cycle N. 16 and for plages without sunspots. A previous conclusion is confirmed, namely, that the stability of M-streams is associated with the local magnetic fields of active regions. The concept, according to which each corpuscular stream above an active region is an assembly of stable and relatively dense tubes of force with frozen-in magnetic fields, is considered from a general point of view. The following facts confirm this hypothesis: (a) The presence of frozen-in magnetic fields in the streams; this is established by direct methods. (b) Increased density of the corona above active regions, found by radio astronomical, polarimetric and optical methods. (c) Straight rays above active regions on eclipse photographs. (d) Fine structure of corpuscular streams deduced from the structure of M-disturbances. The article deals with properties of the magnetic tubes above active regions and the problem of their origin. The appearance of relatively hot and dense regions of gas in the corona above an active region (with bright emission in λ 5303 Å) leads to the expansion of gases and to their upward movement. Owing to the presence of local magnetic fields this expansion leads to the formation of tubes. The upward movement of gases proceeds with some acceleration and after a time the forward section of the tube reaches a level in the corona where further movement of the relatively dense gas occurs roughly under conditions of expansion into vacuum. In this case the gas velocity (theoretically for $t \to \infty$) is close to 3 c_0, where c_0 is the velocity of sound. It is found that $v \approx 650$ km/sec. Owing to the presence of a magnetic field in the tubes, transverse expansion of each tube is relatively small. Thus the corpuscular streams must be approximately radial even at large distances from the sun. (auth)

13273 GENERATION OF FLARES BY VARYING MAGNETIC FIELDS ON THE SUN. A. B. Severnyi (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 299-303(Nov.-Dec. 1961).

Some new observations on the behavior of magnetic fields during flares are described. Pronounced changes are revealed from a comparison of the magnetic fields present before and after a flare and there are indications of rapid changes of the surrounding field at the onset of flare. At the same time no appreciable changes of field at the very place of flare are found after the onset of flare. Motion pictures in Hα and spectra of limb flares show the occurrence of ejections out of flare with a velocity gradient along the jet. The observed far wings of Balmer lines in limb flares agree better with radiation emission from a jet broadened by the velocity gradient than with line profiles produced by Stark and even Doppler effects, although Stark broadening is sometimes still adequate to explain observed profiles, especially their central parts. Experiments in the pinch effect in hydrogen show that Balmer lines are broadened mostly by Stark effect when viewed across the axis of

the discharge and by the velocity-gradient (produced by the pinch sausage instability and ejection of plasma through holes in the electrodes) when viewed along the axis. The generation of a flare is considered to be due to the contraction of solar plasma, initially in equilibrium and concentrated near a neutral point, under the action of the increasing external magnetic field of sunspots. It has been shown that even a comparatively slow increase in this field can lead to a rapid comparison of the plasma, giving rise to shock waves converging to the neutral point and to the ejection of plasma from the region between the shock-wave fronts in a direction perpendicular to the compression. It is also shown that ohmic losses can play an important role in the slow heating of faculae. (auth)

13274 PATH OF FLOW IN A MAGNETIC TUBE CONNECTED TO THE SUN. L. S. Marochnik. Soviet Astron. AJ (English Transl.), 5: 304-10(Nov.-Dec. 1961).

A solution is found for the stationary equations of magnetohydrodynamics for a compressible ideal fluid at $\sigma = \infty$ in a frame of reference which is rotating at constant angular velocity. The constraint $v \| H$, which is clearly valid in solar corpuscular streams, is employed as a simplifying assumption. The evolution of paths of flow in response to small steady-state disturbances is studied. The final form is that of a spiral. The delay time of M-perturbations turns out to be of the order of 4-6 days, in agreement with observational data. Estimates are made of the relative stability of the flow path. Considerable variations in delay may occur approximately 3-9 months following the onset of damping in the active region, i.e., in accordance with observations delay remains virtually constant for a given sequence of geomagnetic disturbances. (auth)

13275 ACTIVE SOLAR REGIONS AND THEIR CORPUSCULAR EMISSION. A. S. Dvoryashin, L. S. Levitskii, and A. K. Pankratov (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 311-25(Nov.-Dec. 1961).

A study is reported of the relation between absorption at high geomagnetic latitudes and disturbances in the earth's magnetic field, in connection with processes occurring in active solar regions. It is concluded from an analysis of experimental data that high-energy protons (~10–100 Mev) are produced on the sun. A consideration of the large delay in the arrival of the protons and the duration and isotropy of their precipitation into the polar cap, leads to the conclusion that approximately radial magnetic fields (with included irregularities) are present in interplanetary space. Their sources are the local magnetic fields of active regions and the general magnetic field of the sun, which are carried along by the ejected plasma. This conclusion is confirmed by the fact that a rapid arrival of protons from a flare is usually observed if the previous flare in the given region gave rise to a magnetic storm. This means that the protons are injected into an approximately radial magnetic field due to the local magnetic field of the active region, and carried along by the previously ejected plasma. The several prolonged polar cap absorptions during 1957–1959 are explained by the injection into this field of high-energy protons associated with the development of flares, the protons being produced within the given active region during its passage across the solar disc. Since the magnetic field remains associated with the sun, the rotation of the sun tends to bend the magnetic lines of force even at the distance of 1 A.U. This is confirmed by the difference in the arrival delay time of high-energy protons injected from active regions located on the west and east hemispheres of the sun. It is established that magnetic storms with SC, which are due to the injection of solar plasma during the development of chromospheric flares and are accompanied by the generation of high-energy protons, have as a rule a shorter delay time, a larger SC amplitude, and are accompanied by a larger Forbush decrease in the intensity of galactic cosmic radiation. A relation is found between the intensity of magnetic storms and the coordinates of flares. Using the flare-storm identification, it is shown that a disturbance from the sun is propagated very nearly through a complete hemisphere, the main mass of the "stream" being concentrated in a 60° cone. (auth)

13276 CONTINUOUS EMISSION FROM THE CHROMOSPHERE BEYOND THE BALMER LIMIT DURING THE 1954 SOLAR ECLIPSE. D. Ya. Martynov (Sternberg Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 329-32(Nov.-Dec. 1961).

The free-bound emission of the solar chromosphere at different heights above the boundary of the photosphere is found using spectrograms obtained during the 1954 solar eclipse. This enables the determination of electron density at different levels of the lower chromosphere, adopting various assumptions for the electron temperature. By taking into account the displacement of emission of different wavelengths on slitless spectrograms, it was possible to recalculate analogous data obtained by Athay and others during the 1952 eclipse. (auth)

13277 THE DEPENDENCE OF LINE INTENSITIES IN THE SOLAR SPECTRUM OF THE PHASE OF SOLAR ACTIVITY. T. E. Derviz, N. F. Kuprevich, and L. A. Mitrofanova (Central Astronomical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 333-8(Nov.-Dec. 1961).

Photometric recordings of the solar spectrum were obtained at Pulkovo during the summer months from 1951–1959. The study was made in order to elucidate the variations of central intensities and equivalent widths of spectral lines in relation to the 11-year cycle of solar activity. The observations were made in the spectral region 4000-4500 Å. The equivalent widths and central intensities in this interval of wavelengths are computed and their mean obtained for each year. No variations of the equivalent widths are detected. The variations of the central intensities with approach to the years of maximum solar activity are more certain. An analysis of the graphs permits the conclusion that the maximum solar activity, determined from the Wolf numbers, coincides with the minimum rate of variation of the central intensities of various chemical elements. This fact may possibly be used as a new criterion for the study of physical conditions in the solar atmosphere. (auth)

13278 THERMOELECTRIC PHENOMENA ON THE SUN. I. THE ELECTROSTATIC FIELD IN THE SOLAR CORONA. G. N. Shtil'shtein (Leningrad Pedagogical Inst.). Soviet Astron. AJ (English Transl.), 5: 344-51(Nov.-Dec. 1961).

This paper discusses the possibility of electric currents appearing in the solar corona owing to different charges on unevenly heated coronal regions. Dissipation of gas from the bulk of the corona is computed with deceleration taken into account. The coronal charge and electric field are found from the principle of electrostatic stationarity. Deviations of the velocity distribution of particles from a Maxwellian distribution are calculated. It is shown that the contribution of a deviation from equilibrium distribution decreases the flow of protons by one order of magnitude and results in increased electric field and charge. Electric fields and accompanying magnetic fields are evaluated. It is shown that appreciable magnetic fields can

become established in the corona of stars, owing to thermal currents. (auth)

13279 ON POLARIZATION IN CORONAL STREAMERS. I. D. Gits (Inst. of Terrestrial Magnetism, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 352-4(Nov.-Dec. 1961).

On the basis of a photometric study of polarimetric photographs of the corona on June 30, 1954 (made with a triple-objective camera, 1/6, f = 45 cm), the distribution of polarization was obtained for east and west rays at distances 3-4.5 $R_\odot$ from the center of the sun's disk. Polarization increases in the west ray to attain 85%, then remaining constant at that level. In the east ray, the degree of polarization hits a maximum (68%) at a distance of 3.5 $R_\odot$ out, and then falls off with distance. This latter fact is accounted for in terms of the curvature of the ray. Calculations are used to pinpoint the position of the streamers (rays) in space. (auth)

13280 AN ESTIMATE OF THE ELECTRON DENSITY IN THE CORONA FROM OBSERVATION OF SOLAR RADIO EMISSION. I. G. Moiseev (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 402-3(Nov.-Dec. 1961).

The height of the lower boundary of the layer with an electron concentration of $N_e = 5 \times 10^8$ cm^{-3} is estimated from the delay time of radio bursts of type II on 1.5 m relative to the appearance of the same type of bursts on 10 cm. (auth)

13281 FORMATION OF CORONAL CONDENSATIONS ABOVE ACTIVE REGIONS. S. B. Pikel'ner (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 412-13(Nov.-Dec. 1961).

The enhancement of L_α radiation shows that the flux of wave energy is about 5 times as high in active regions as that in the quiet sun. This corresponds to an increase in the convection velocity by less than 20%. The base of the corona is lower and more dense above active regions than above undisturbed regions. The shape of coronal rays depends on the magnetic field, which in turn is changed by gas pressure. (auth)

13282 ON EQUILIBRIUM CONFIGURATIONS OF SUPERDENSE DEGENERATE GAS MASSES. V. A. Ambartsumyan and G. S. Saakyan (Byurakan Astrophysical Observatory, Academy of Sciences, Armenian SSR). (Soviet Astron. AJ (English Transl.), 5: 601-10(Mar.-Apr. 1962).

Equilibrium densities of stellar masses possessing a density of the same order as the density of the atomic nucleus, and consisting of a highly degenerate baryon gas, are discussed. This treatment differs from that of Oppenheimer and Volkoff in that the presence of hyperons at high densities is considered. The treatment is based on the Einstein gravitational equations. The possible existence of some equilibrium configurations containing a large number of hyperons is pointed out. The equilibrium models are computed for both an "ideal" Fermi gas and a real gas in which interaction between particles is taken into account. (auth)

13283 THE SPECTRUM OF LOCAL SOURCES OF SOLAR RADIO EMISSION. A. P. Molchanov (Main Astronomical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 651-4(Mar.-Apr. 1962).

The relative spectrum of a solar radio source observed during a solar eclipse is presented. The mean exponent of the spectrum is determined from measurements of the maximum shift of the center of gravity of solar radio emission. The absolute spectrum is calculated with several assumptions concerning the dependence of the unperturbed radiation flux on the wavelength. The magnetic field in the source is found from the exponent of the spectrum. It is found that it is necessary to assume either the presence of a strong magnetic field in the source or the existence of nonthermal radiation. (auth)

13284 OVERALL STRUCTURE OF THE SOLAR CORONA ON FEBRUARY 15, 1961. S. K. Vsekhsvyatskii and V. I. Ivanchuk (Kiev State Univ.). Soviet Astron. AJ (English Transl.), 5: 655-9(Mar.-Apr. 1962).

A schematic diagram of the corona of February 15, 1961, based on photographs obtained by the Leningrad State University expedition teams at Belebei, Dzhankoe, and in airborne sorties, is given. Particular features of fans and of systems of polar rays were prominent. The February 15, 1961, corona is one of intermediate type (according to Gansky). The correspondence between ray structures and excitation regions in the solar chromosphere was considered. Stable fans terminating in straight rays as corpuscular streams originate in filament and prominence regions. No rays were observed above facular and floccular fields. Attention is directed to the existence of a puzzling formation accompanying the more familiar coronal forms known from previous investigations, this structure being a dark and possibly absorbing ray in the eastern half of the northern polar region and two intense streams in the south polar region. The extent of the fans was measured and the results were compared to similar data from previous eclipses. At solar activity minimum, the extent was found to be largest, and was found to decrease at solar activity maximum. The conclusion drawn was that the extent is determined in the first instance by the strength of the variable general magnetic field. (auth)

13285 MAGNETIC FIELDS IN SOLAR PROMINENCES. G. Zirin (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 660-6(Mar.-Apr. 1962).

Zeeman splitting of H_β and a system for calibrating measurements of magnetic fields in H_β in solar prominences are discussed. A review of observations carried out in November and December 1950, with the magnetograph of the Crimean Astrophysical Observatory shows surprisingly large fields. The magnetic field in active prominences reaches 200 gauss, almost always corresponded to by the field of the same sign on the solar disk. Quiescent prominences exhibit a field on the order of 50 gauss. (auth)

13286 ON THE APPLICABILITY OF THE THEORY OF STRONG EXPLOSIONS TO CHROMOSPHERIC FLARES. R. E. Guseinov (Shemakhin Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 5: 667-72(Mar.-Apr. 1962).

The kinetic energy of a limb flare has been estimated (5×10^{26} ergs) applying the theory of a strong explosion with cylindrical symmetry. The flare was observed in H_α using an interference-polarization filter with a pass-band of 0.5 Å attached to the AFR-2 chromospheric telescope of the Shemanin Astrophysical Observatory. The energy emitted by the flare in H_α (taking into account the energy in the lines within the interval λ 3300–11,500 Å), L_α, λ 304 Å He II and also in the x ray and continuous spectrum is estimated. The total magnitude of all these forms of energy for the observed class +1 flare is of the order of ~10^{28} ergs. Taking into account that solar cosmic rays could lead to an increase of this value by several orders

of magnitude, it is concluded that, if the flare is the result of a strong explosion, the kinetic energy of the flare is insufficient for compensating the energy lost by the flare as all forms of radiation. Therefore, the total energy, liberated as a result of an explosion, should be considerably higher than the kinetic energy of shock waves. The temperature of the flare is estimated for definite values of the parameters S (the flare area) and h (the height of the flare above the limb), corresponding to the time at which the dimensions of the region in which the shock wave acts become equal to S (and h) with the given amount of kinetic energy liberated. It is found to be 8×10^5 K. On the basis of the character of flare development and the assumption that the explosion is practically instantaneous and concentrated in a small region, it is estimated that the temperature of the core of the flare is 8×10^5 K. This is in good agreement with rocket data. In connection with this it is concluded that flare phenomena affect temperatures. The kinetic energy density of the shock wave is estimated. It is 2×10^3 ergs/cm^3, which is in good agreement with the estimates made by A. B. Severnyi from an investigation of the excitation and ionization of hydrogen in chromospheric flares, the investigation of continuous nonstationary emission from flares and moustaches, as well as the pinch-effect. (auth)

13287 DYNAMICS OF NOVA ENVELOPES. V. G. Gorbatskii (Leningrad Univ. Observatory). Soviet Astron. AJ (English Transl.), 6: 154-61(Sept.-Oct. 1962).

The motion of an envelope of a nova during the period from light maximum to the nebular stage is considered. Corpuscular radiation of the nova is the main factor acting on the envelope at this time. Momentum is imparted to the envelope by particles ejected from the star. The law of motion of the envelope is obtained. The problem of the interaction between the envelope and the gaseous stream flowing after it is solved in the one-dimensional case. It is shown that the influence of the interaction between particles of the stream on the law of motion of the envelope is small. Corpuscular radiation is very intense close to the moment of light maximum. If the particles are ejected from the star in predominant directions or if the envelope of the star does not have spherical symmetry, the action of the corpuscular stream can lead to a division of the envelope into separate parts. The minimal dimensions of clouds of such origin are estimated. Available observational data show that the breaking-up of the envelope into discrete clouds has actually occurred in some cases. (auth)

13288 SUPERNOVA OUTBURSTS AND THE INTERSTELLAR MEDIUM. I. S. Shklovskii (Sternberg Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 6: 162-6(Sept.-Oct. 1962).

Grounds are given for the conclusion that a supernova outburst in the interstellar medium can be considered as an adiabatic strong explosion in a medium with constant thermal capacity. The automodular solution of the strong explosion problem is applied for studying the character of disturbances in the interstellar medium surrounding the supernova. Thus, in particular, a new formula is obtained for the deceleration time of expanding nebulae — remnants of supernova outbursts. Astrophysical consequences which follow from this discussion of the character of disturbances in the interstellar medium during supernova outbursts are considered briefly. (auth)

13289 SOLAR RADIO EMISSION ON A WAVELENGTH OF 8 mm. A. E. Salomonovich (Lebedev Physics Inst., Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 6: 202-9(Sept.-Oct. 1962).

Observations made at the Lebedev Physical Institute since 1954 led to the discovery of an emission component of the quiet sun, the brightness temperature distribution of which over the disc is in agreement with a two-component model of the chromosphere, and also a slowly varying component correlated with the total sun spot area Σ Sp (the correlation coefficient is 0.4 ± 0.04). The minimum brightness temperature of the sun obtained by extrapolation to Σ Sp = 0 is $7500° \pm 900°$. The relation between the averaged temperature and the degree of solar activity was confirmed by the two-dimensional distribution of "radio images" of the sun found from observations with the 22-meter radio telescope. Enhanced emission is observed from regions above large (Sp $\geq$ 100) spot groups, which apparently is the emission from coronal condensations. The angular size of the most active regions (Sp > 300–500) is 1-2 minutes of arc. Enhanced emission is also observed from more extended regions with dimensions close to those of facular fields (plages) and equal to 4′ -5′. The excess in brightness temperature of the above regions above that of the quiet sun is $(2.5\text{-}6)10^3$ °K. The regions with emission increase have been identified with optical active regions on the solar disk. The dynamics of development of 10 regions were followed. Simultaneous measurements on 8 mm and 3.2 cm, made during separate days, showed that the flux density at both wavelengths has about the same value, which is evidence that local sources are apparently of thermal origin and optically thin at the above wavelengths. Bursts of radio emission, the commencements of which coincided with chromospheric flares, were localized on 8 mm. The angular dimensions of the bursts and the maximum brightness temperatures ($10^4 - 10^6$ °K) are estimated. (auth)

13290 THE SPATIAL STRUCTURE OF THE SOLAR CORONA. [PART] I. E. R. Mustel' (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 6: 333-9(Nov.-Dec. 1962).

General problems connected with the study of the spatial structure of the solar corona are presented, the main attention being given to those problems which are related in one way or another to corpuscular streams. Problems dealing with the connection between quiescent prominences-filaments and the coronal streamers above them are considered. General regularities in the structure of the solar corona are discussed. For this purpose special consideration is given to the "intermediate" type of corona, characterized by decreased brightness in the low latitude belt of the sun (including belts of active regions) and increased brightness in the middle latitude belts (belts of streamers). Two hypotheses explaining the main properties of the low latitude belt are considered. In the first hypothesis these properties are determined by such "large-scale" solar characteristics as the general magnetic field of the sun, its rotation, etc. In the second hypothesis the above properties are determined by the active regions deviating the corpuscles of continuous ejection of coronal gases from the sun ("solar wind"), and producing above themselves relatively empty cavities. It is shown that the second hypothesis meets with serious difficulties. The main geometrical properties of the streamers are discussed. The extension of the streamers is given special attention. Many arguments are given in evidence that the total length of the streamers is of the order of $30R_\odot - 50R_\odot$; even if the streamers extend to the earth's orbit they are very weak. In any case the streamers cannot be the source of M-disturbances. The paper by Waldmeier is discussed and it is concluded that his main

conclusions meet with many difficulties. The coronal rays above active regions will be discussed and the results of eclipse (optical) observations brought into agreement with radio-astronomical and polarimetric data. (auth)

13291 X-RAY EMISSION FROM FLARES. A. S. Dvoryashin, L. S. Levitskii, and A. K. Pankratov (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 6: 340-8(Nov.-Dec. 1962).

World data on the ionosphere (f_{min}), radio outbursts on centimeter wavelengths, and chromospheric flares are used in this paper. The study of the connection between the time characteristics (time of commencement, maximum, and termination) of x-ray and radio emission from flares and characteristics obtained from observations in the optical region of the spectrum show that the time variations of x rays and radio emission are practically the same. The radiation of the flare in H_α, however, commences before the other phenomena are observed. From a comparison of the minimum reflection frequencies f_{min}, registered during ordinary and proton flares, it is found that proton flares produce a considerable increase in x-ray intensity. A strong hardening of the x-ray spectrum of the intense proton flares of March 23, 1958, and July 14, 1959, was detected. On the assumption that additional ionization in the ionosphere originates at heights of 60 km (at tangential incidence of radiation on the D layer), it is concluded that protons with energies of up to ~1 Mev are generated during the development of intense proton flares. (auth)

13292 OBSERVATIONS OF THE SPECTRA OF SOLAR RADIO OUTBURSTS IN THE 10-25 Mc REGION ON JULY 14 AND 18, 1961. L. G. Sodin, S. Ya. Braude, and A. V. Men'. Soviet Astron. AJ (English Transl.), 6: 423-5(Nov.-Dec. 1962).

The results of observations of spectra of very intense bursts of solar radio emission on July 14 and 18, 1961, are given. The observations were made in the 10–25 Mc region. The complex structure of the spectra is noted. These consist of a large number of relatively narrow-band bursts which continuously change their shape and position on the frequency axis. (auth)

13293 ON THE CAUSE OF NOVA OUTBURSTS. T. A. Éminadze (Shemakhin Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 6: 431-3(Nov.-Dec. 1962).

Several observational results indicate that novae before their outburst are white dwarfs. According to Krizhnits and the author the rate of nuclear processes in a medium of high density is highly reduced since the matter is in a condensed state. This makes possible the presence of hydrogen in white dwarfs. The cause of nova outbursts is considered from this point of view. The onset of expansion in a white dwarf leads to the "evaporation" of the condensate. Thermonuclear reactions produced by protons will then set in. This will lead to a more intense "evaporation" of the condensate and thus to an increase in the temperature. As a result, the rate of thermonuclear reactions will increase and give rise to a nova. If the expansion takes place in a considerable fraction of the star, it will give rise to an outburst of the supernova type. (auth)

13294 THE MAGNETOSPHERE DURING MAGNETIC STORMS: A WHISTLER ANALYSIS. Donald Leland Carpenter. Thesis, Stanford, Calif., Stanford Univ., 1962. 82p.

A new extension method of scaling ordinary whistlers for frequency and delay at the whistler nose is described. The method provides a substantial increase in the number of whistlers from which information on electron density in the magnetosphere can be obtained. A study of the experimental error shows that the extension method provides information on electron-density level that is comparable in accuracy with that obtained from direct observations (relatively rare) of nose traces. As a result of applying the new scaling method to a large number of whistlers recorded during the period 1957-61, it was found that substantial depressions in magnetospheric electron density occur during magnetic storms. (The range of observations, in geocentric distance, extends from 2 to 4 earth radii in the geomagnetic equatorial planes.) The majority of storms during which the 3-hour K_p index reaches 6 or more show density reductions that are on the order of 20%; while in some very severe storms, much larger depletions, by as much as an order of magnitude, are observed. These results had not been predicted, either by theory or by the relatively small amount of relevant information from satellites. Some of the physical processes that may be related to the observed depressions are discussed qualitatively. It is suggested that F-region heating and changes in the coupling between the F region and the magnetosphere may provide the mechanism of the depressions. It is shown that the interpretation of the whistler results in terms of variations in electron density is justified, since large disturbances in the magnetic field cannot by themselves produce the patterns exhibited by the data. (P.C.H.)

Cosmic Radiation

13295 (AFOSR-418) A STUDY OF IONOSPHERIC ABSORPTION PRODUCED BY SOLAR COSMIC RAYS. Robert Anthony Weir, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). [1961]. 108p.

The absorption of cosmic radio noise in the lower ionosphere due to the arrival of solar cosmic rays has been calculated for several locations at the high magnetic latitudes. The calculation is made in three parts; the volume production rate of electrons from ionization, the equilibrium electron density resulting from the competition between production and recombination processes, and the absorption of electromagnetic radiation passing through the ionized region. The calculation is made for proton energy spectra in the form of power law as observed by balloon-borne detectors following large solar flares. The calculated absorption is compared with observations obtained by riometers (relative ionospheric opacity meter) at Point Barrow, Fort Yukon, College, and Farewell, Alaska. For the solar proton event of July 14, 1959, the calculated absorption based on balloon data does not agree in magnitude nor latitude variation with the observations obtained by the Alaskan riometers. The lack of agreement in absolute magnitude indicates that the atmospheric coefficients used in obtaining the equilibrium electron density are in error. In particular, the collisional detachment as well as electron attachment coefficients appear to require considerable revision. The lack of agreement in the latitude variation substantiates observations at rocket altitude that indicate that the power law energy spectrum flattens considerably at proton energies below 100 Mev. 32 references. (auth)

13296 (N62-11289) PRELIMINARY SURVEY OF EXPLORER VII OBSERVATIONS OF SOLAR COSMIC RAYS, NOVEMBER 12-23, 1960. J. A. Van Allen (Iowa. State Univ., Iowa City). Jan. 11, 1961. Revised Jan. 26, 1961. Contract NASw-17. 10p.

Solar cosmic ray intensities and low altitude thresholds

for the clear observation of the arrival of solar protons as observed by Explorer VII during November 12-23, 1960, are listed. Conditions and restrictions affecting the gathering of the data are commented upon, and inferences from the data are briefly discussed. (D.C.W.)

13297 (NAA-SR-7849) A DISCUSSION AND BIBLIOGRAPHY OF CURRENT LITERATURE CONCERNING VAN ALLEN BELTS FOR USE IN SNAP SPACE ENVIRONMENTAL STUDIES. V. E. Kistler (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1963. Contract AT(11-1)-Gen-8. 47p.

Discussion of theories on particle motion in electric and magnetic fields precedes examination of theories on the source of the inner and outer Van Allen belts. Theories for the inner belt propose solar cosmic ray injection and galactic cosmic ray injection as the source of the protons. Neutron albedo is particularly examined but seems to be unaccountable for the proton belt. Neutron albedo and injection from the sun are also considered as possible sources of the electrons in the outer belt. Fluctuations, intensities, and distributions of the belts are also discussed, and the connection between the belts and aurora displays is examined. Fluxes, spectra, and particle intensities are displayed, and the effects of magnetic storms on the belts are analyzed. 150 references. (D.C.W.)

13298 (NASA-TN-D-1679) ON THE ANOMALOUS COMPONENT OF LOW-ENERGY GEOMAGNETICALLY TRAPPED PROTONS. A. M. Lenchek (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Feb. 1963. 18p.

The energy spectrum of trapped protons shows a pronounced variation with latitude at energies below 30 Mev. An anomalous, low-energy component is found on relatively high magnetic shells in the inner zone. The interpretation of this anomalous component in terms of the decay of albedo neutron generated in the polar caps by solar cosmic ray is examined. This interpretation requires that the inner shells, where a normal spectrum is seen, should be shielded from the polar source. The intensity of albedo neutrons as a function of energy, latitude, and zenith angle is computed. The injection rate into specific trapped orbits is then evaluated and it is shown that those orbits where no anomalous component exists cannot be populated by the solar cosmic ray mechanism while the orbits where the anomalous component is seen can be populated. When the assumption is made that there is adiabatic trapping in this low energy region, lifetimes are long compared to the average interval between large injection events. Therefore, the anomalous component may represent an equilibrium phenomenon rather than a transient. This component should extend into the outer belt. 27 references. (auth)

13299 (NASA-TN-D-1696) NEUTRONS IN SPACE. Wilmot N. Hess (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Feb. 1963. 8p.

The various neutron sources in the solar system are discussed. Because of the neutrons' half life, very few neutrons come into the solar system from outside. Cosmic rays interacting with the atmosphere or surface of the planets are the major neutron source near the planets. Studies of the neutron energy spectrum can give some information about the chemical composition of the planets. The sun is a source of neutrons from several processes. Thermonuclear burn in the corona and leakage from the burning cone do not seem to be important sources, but a significant number of neutrons may result from high energy protons accelerated in flares on the sun. (auth)

13300 DIURNAL AND SEASONAL VARIATIONS IN D-REGION ELECTRON DENSITIES DERIVED FROM OBSERVATIONS OF CROSS MODULATION. R. E. Barrington, E. V. Thrane, and B. Bjelland (Norwegian Defence Research Establishment, Kjeller, Norway). Can. J. Phys., 41: 271-85(Feb. 1963).

Pulsed cross modulation, arising in the region from 60 to 80 km, was observed during undisturbed days in the spring, summer, and fall of 1960. The manner in which these observations are obtained and the uncertainties associated with the electron-density profiles determined from them are discussed. Average electron-density profiles for each hour of quiet spring days are deduced. These show that the most rapid changed in electron density occur within one hour of ground sunrise and sunset. Around sunrise a rather uniform layer of about 100 electrons/cc is created almost simultaneously throughout the entire region from 60 to 80 km. As the day progresses, the average electron density between 70 and 80 km changes by a factor of about 10, while the average density between 60 and 70 km changes by only a factor of 2. These features of the D region are discussed in the light of theoretical predictions, which assume that cosmic rays and solar Lyman-alpha radiation account for the normal ionization in this region. (auth)

13301 NEW INDICATIONS ON THE EXISTENCE OF LARGE JETS OF AIR ATTRIBUTABLE TO PRIMARY PHOTONS. Ryszard Firkowski, Jerzy Gawin, Roland Maze, and Alexandre Zawadzkr. Compt. Rend., 255: 2411-13(Nov. 5, 1962). (In French)

Large jets abnormally pure in penetrating particles attributable to primary photons were detected. The frequency of these jets represents 1% of that of ordinary jets of the same size. (tr-auth)

13302 THE ELECTRON DISTRIBUTION IN THE EARTH'S RADIATION BELTS DURING JULY 1962 AS MEASURED BY TELSTAR. W. L. Brown and J. D. Gabbe (Bell Telephone Labs., Murry Hill, N. J.). J. Geophys. Res., 68: 607-18(Feb. 1, 1963).

Results obtained from the electron detector on Telstar between July 10 and 31, 1962, are presented. The principal sensitivity of the detector is to electrons of energies between 0.25 and 1.0 Mev. Flux maps have been drawn for days 193-197, 203-207, and 208-212, 1962. Maximum omnidirectional electron fluxes of approximately $10^9/cm^2$ sec were encountered with energies in excess of 200 kev near the magnetic equator at L's of about 1.25 and 1.8R. The intensity decreased exponentially with a time constant of about 4.5 days between L values of 2.2 and 3.0 and with a time constant of about 15 days at L = 2.0 and 3.5, creating a slot between the inner and outer electron belts that had become pronounced by the end of July. The energy spectrum encountered seems to contain a substantial number of electrons with energies of about a Mev or more and is not inconsistent with the fission β spectrum above 400 kev. At lower energies the spectrum is steeper. Within the sensitivity of the measurement no spectral changes with either position or time were observed. Because of Telstar's launch date it is not possible to conclude what fraction of the electrons measured were produced by the high-altitude nuclear test of July 9. In spite of the high flux of electrons encountered, electrons are not the major source of radiation damage to the Telstar solar power plant. (auth)

13303 SATELLITE OBSERVATIONS OF THE ARTIFICIAL RADIATION BELT OF JULY 1962. J. A. Van Allen, L. A. Frank, and B. J. O'Brien (State Univ. of Iowa, Iowa City). J. Geophys. Res., 68: 619-27(Feb. 1, 1963).

The earlier paper by O'Brien, Laughlin, and Van Allen on the earth's artificial radiation belt of July 1962 is reviewed and some additional data from Injun 1 on absolute intensities and time decay are given. The results and implications of this series of observations are shown to be in marked disagreement with the summary interpretation of Injun 1, Ariel, Traac, and Telstar data proposed by Hess and Nakada. New SUI observations by means of Explorer 14 in early October 1962 are reported and are found to be more or less consistent with the results of O'Brien, Laughlin, and Van Allen, but they can be reconciled with the interpretation of Hess and Nakada only by means of one or more heroic assumptions. (auth)

13304 SATELLITE MEASUREMENTS OF THE ARTIFICIAL RADIATION BELT. R. V. Smith and W. L. Imhof (Lockheed Missiles and Space Co. Research Labs., Palo Alto, Calif.). J. Geophys. Res., 68: 629-33(Feb. 1, 1963).

Preliminary results from measurements of electron fluxes in the new artificial belt are presented. Data were collected during the period September 1 to 5, 1962, from a satellite in an orbit with 83° inclination, 689-km apogee, and 304-km perigee. Threshold detectors, consisting of shielded plastic scintillators, measured the fluxes of electrons of energy greater than approximately 1, 2, and 5 Mev. The data are presented in the form of electron fluxes plotted as a function of B for fixed L crossings. Comparisons are made with the compilation by Hess. (auth)

13305 TRAAC OBSERVATIONS OF THE ARTIFICIAL RADIATION BELT FROM THE JULY 9, 1962, NUCLEAR DETONATION. G. F. Pieper and D. J. Williams (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 68: 635-40(Feb. 1, 1963).

A 302 Geiger counter on the Traac satellite has provided data about omnidirectional electron fluxes in the region $0.20 \leq B \leq 0.34$ gauss and $1.1 \leq L \leq 2.4$ earth radii after the July 9, 1962, nuclear explosion. Data taken 1 and $9\frac{1}{2}$ hours after the explosion show a decay of a factor of ~50 in the flux seen at B = 0.230 gauss, L = 1.216 earth radii. Data taken between July 10 and 18 have been used to establish contours of constant flux. They appear to show a shift of particle mirror points to higher values of B in the L region ~1.7 to ~2.0 on July 14, 1962 or an increase in flux from an unknown source. (auth)

13306 PRELIMINARY ANALYSIS OF THE FLUXES AND SPECTRUMS OF TRAPPED PARTICLES AFTER THE NUCLEAR TEST OF JULY 9, 1962. F. S. Mozer, D. D. Elliott, J. D. Mihalov, G. A. Paulikas, A. L. Vampola, and S. C. Freden (Aerospace Corp., Los Angeles). J. Geophys. Res., 68: 641-9(Feb. 1, 1963).

Particle detectors have been flown on a low-altitude, polar satellite to measure the fluxes and energy spectrums of protons and electrons. In the region of the South Atlantic magnetic anomaly, electrons were observed with a fission-like spectrum above 2 Mev. Comparison on B, L plots of the electron fluxes with those obtained one week after the explosion indicates that the electron lifetime is $\gtrsim$ 20 days. The lifetime and the observed deficiency of fission electrons below 2 Mev are consistent with the loss mechanism of atmospheric interaction. Near L = 4.5 and B = 0.4 gauss, only natural electrons were observed. The proton flux and spectral measurements yield no evidence that protons were either injected into or removed from the radiation belt by the high-altitude explosion. (auth)

13307 A SECOND RADIATION BELT FROM THE JULY 9, 1962, NUCLEAR DETONATION. G. F. Pieper (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 68: 651-5(Feb. 1, 1963).

A second artificial radiation belt from the July 9, 1962, nuclear detonation has been discovered by means of a Geiger counter on the Traac satellite. The source of the second radiation belt is believed to be decay electrons from fission fragments that fell back onto the top of the atmosphere after the detonation. The spatial characteristics of the belt are given and its origin and time history are discussed. (auth)

13308 ARTIFICIAL RADIATION BELT STUDIES WITH A FISSION BETA-RAY SOURCE. H. T. Motz and R. E. Carter (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 68: 657-61(Feb. 1, 1963). (LADC-5502)

The magnetic trapping of electrons from recent high-altitude nuclear testing resulted in a flux of high-energy electrons whose spectrum is believed to be quite similar to that from uranium undergoing fission at equilibrium. A reactor facility using a foil under such conditions has been assembled to study the response of a Geiger counter to a fission β spectrum for various absorbers. This facility has also been used to measure the fission β response of the background counter in an Injun satellite counter assembly, and to measure the pulse-height distribution from a detector similar to that used in the Telstar satellite. (auth)

13309 THE ARTIFICIAL RADIATION BELT MADE ON JULY 9, 1962. W. N. Hess (National Aeronautics and Space Administration, Greenbelt, Md.). J. Geophys. Res., 68: 667-83(Feb. 1, 1963).

The available information on the artificial radiation belt formed by the July 9, 1962, high-altitude nuclear explosion is reviewed. Data from Injun ($1961o_2$), Telstar 1 ($1962\alpha\epsilon_1$), Traac ($1961\alpha\eta_2$), and Ariel 1 ($1962o_1$) are combined to form one picture of the artificial belt. The data are consistent to about a factor of 3. The flux map obtained in this way is used to calculate the flux encountered by several satellites. These show reasonable agreement with data on solar cell damage. Crude calculations of shielding are made to indicate the doses received inside various vehicles. (auth)

13310 TRAPPED ELECTRON TIME HISTORIES FOR L = 1.18 TO L = 1.30. J. A. Welch, Jr. (Air Force Special Weapons Center, Albuquerque, N. Mex.), R. L. Kaufmann, and W. N. Hess. J. Geophys. Res., 68: 685-99(Feb. 1, 1963).

Numerical integration of a Fokker-Planck equation including atmospheric scattering and energy loss has been used to predict the time decay of electrons injected into the geomagnetic field by the July 9, 1962, nuclear explosion over Johnston Island. Calculations were performed for L = 1.18, 1.25, and 1.30 using an atmosphere characteristic of sunspot minimum and averaged over longitude, keeping L and B fixed. Deviations of the calculated and observed spatial distribution at one week after the injection are attributed to the overly simplified initial conditions. The early decay follows closely the form $\tau/(t + \tau)$ and is followed by an exponential decay at later times. For L = 1.25, τ varies from 10^4 sec at B = 0.21 to 10^7 sec at B = 0.16 (the equator). The exponential decay for L = 1.25 has a mean life of 1.3×10^8 seconds. Decay is accompanied by spectral hardening. After any substantial decay the spectrum is peaked at about 1.5 Mev. (auth)

13311 A NEW METHOD OF COMPUTING COSMIC-RAY CUTOFF RIGIDITY FOR SEVERAL GEOMAGNETIC FIELD MODELS. Herbert H. Sauer (State Univ. of Iowa, Iowa City). J. Geophys. Res., 68: 957-71(Feb. 15, 1963).

An approximate method of computing cosmic-ray cutoff rigidities is presented. The geomagnetic field is represented by the combination of a sixth order magnetic field whose origin lies entirely within the earth, and that due to a filamentary equatorial ring current of various radii and

magnetic moments. The sixth order spherical harmonic expansion of the scalar magnetic potential is that obtained by Finch and Leaton by numerical analysis of surface magnetic field measurements for epoch 1955. Vertical cutoff rigidities have been computed for all IGY stations of geomagnetic latitude greater than ±45° listed in the Annals of the International Geophysical Year, vol. 8. In addition, the vertical cutoff ridigities have been calculated for geographic latitude steps of 5° in geographic longitude steps of 10° for the sixth order field alone in regions of geomagnetic latitude greater than ±45°. The results are compared with the values given by Quenby and Webber, and by Quenby and Wenk, and with those derived from the magnetic shell parameter L. Comparisons of the values of vertical cutoff rigidity obtained for Port aux Francais, Northern Italy, and Minneapolis with those obtained by McCracken, Lynch, and Kellogg, respectively, by calculation of particle trajectories, are consistent with the 5 per cent precision claimed for the present method. (auth)

13312 THE MAGNETIC MOMENT OF MODEL RING CURRENT BELTS AND THE CUTOFF RIGIDITY OF SOLAR PROTONS. S.-I. Akasofu (Univ. of Alaska, College) and W. C. Lin. J. Geophys. Res. 68: 973-7(Feb. 15, 1963).

The magnetic moment M_R of the ring current is calculated for model ring current belts, together with their magnetic fields along an equatorial radius. A graph shows the relation between the ratio M_R/M_E (M_E = the magnetic moment of the earth) and the intensity ΔH of the ring current field at the equator on the earth's surface. It gives possible ranges of the ratio M_R/M_E for observed values of ΔH and approximate upper limits of both M_R/M_E and ΔH for each belt. On the basis of diagram, the entry of low-energy solar protons is discussed, and it is shown that the ring current alone cannot produce the drastic reductions of apparent cutoff rigidity of solar protons observed by detectors carried by balloons and satellites. (auth)

13313 THE 0.5-Mev GAMMA-RAY AND THE LOW-ENERGY GAMMA-RAY SPECTRUM TO 6 GRAMS PER SQUARE CENTIMETER OVER MINNEAPOLIS. Laurence E. Peterson (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 68: 979-87(Feb. 15, 1963).

The positron annihilation line at 0.5 Mev has been found to be a prominent feature of the low-energy γ spectrum produced in the atmosphere by cosmic rays. The measurement, that covered the energy range between 37 kev and 3.5 Mev, is made with a phoswich scintillation counter carried on a balloon to a depth of 6 g/cm^2 over Minneapolis. The flux at 0.5 Mev is found to be 0.31 ± 0.03 photon/cm^2 sec at 6 g/cm^2, and, when extrapolated to zero depth, gives a residual of 0.18 ± 0.03 photon/cm^2 sec. All components of the spectrum, including the line at 0.5 Mev, are observed to have a transition maximum at 90 g/cm^2 and a length for absorption of 180 g/cm^2. These indicate the origin of the low-energy γ rays to be associated with the electronic component of secondary cosmic rays. Evaluation of the source function at 0.5 Mev over the entire atmospheric column gives 8.6 positrons per incident primary cosmic ray at λ = 55° geomagnetic. Since no statistically significant time variations are observed during the seven hours of constant depth balloon flight, an upper limit on the flux of certain possible extraterrestrial point sources, that made high elevation meridian transits, can be obtained. The flux at 0.5 Mev from the quiet sun and from the Crab nebula must be less than about 0.1 photon/cm^2 sec at the earth. (auth)

13314 A LARGE DIURNAL VARIATION OF THE GEOMAGNETICALLY TRAPPED RADIATION. B. J. O'Brien (State Univ. of Iowa, Iowa City). J. Geophys. Res., 68: 989-95(Feb. 15, 1963).

The satellite Injun 1 was used to find the high-latitude termination of trapping of electrons with energy $E \gtrsim 40$ kev at 1000-km altitude over North America. On the average, this termination is at $L \sim 16$ or $\Lambda \sim 75°$ in the local day and at $L \sim 8$ or $\Lambda \sim 69°$ in the local night. As a consequence, in the range $8 \lesssim L \lesssim 16$ or $69° \lesssim \Lambda \lesssim 75°$, the average intensity of trapped electrons is some 100 times greater in the local day than at local night. Several explanations are suggested, but none is proved. The results show that McIlwain's L parameter loses its simple applicability for $L \gtrsim 6$ or $\Lambda \gtrsim 66°$. (auth)

13315 STUDY OF ENERGETIC ELECTRONS AND THEIR RELATIONSHIP TO AURORAL ABSORPTION OF RADIO WAVES. B. Maehlum and B. J. O'Brien (State Univ. of Iowa, Iowa City). J. Geophys. Res., 68: 997-1010 (Feb. 15, 1963).

The high-latitude boundary (L_N) of energetic electrons ($E \gtrsim 40$ kev) quasi-trapped at an altitude of 1000 km is studied with the satellite Injun 1 over North America during periods of magnetic quiet and magnetic storms in 1961. The boundary is very sharp during disturbed periods, and it moves farther from the pole during larger disturbances. The electron intensity south of L_N increases during magnetic disturbances, and the electron spectrum is much softer than normal just at the boundary. Throughout two magnetic storms in October and December 1961, the boundary (L_N) of the energetic electron flux coincides with the boundary of the auroral absorption of radio waves. Quantitative correlation of the intensities of the two phenomena is discussed. 28 references. (auth)

13316 THE AURORA AND TRAPPED ELECTRONS. F. E. Roach (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 1015-21(Feb. 15, 1963).

Some general properties of geomagnetic tubes are considered in an exploration of the possibilities of excitation of auroral 5577 Å by the release of trapped electrons. Two mechanisms are considered: the release of energetic electrons from the tubes; and the acceleration of low-energy electrons after release from the tubes. The possibility that one or both of the mechanisms is operative from the equatorial to the auroral regions is discussed. (auth)

13317 AURORAL ZONE X-RAY PULSATIONS IN THE 1- TO 15-SECOND PERIOD RANGE. C. D. Anger, J. R. Barcus, R. R. Brown, and D. S. Evans (Univ. of California, Berkeley). J. Geophys. Res., 68: 1023-30(Feb. 15, 1963).

Auroral zone x-ray pulsations in the 1- to 15-second period range, observed at Macquarie Island, Australia, on March 5, 1962, and College, Alaska, on June 29, 1962, are described. Both observations indicate that the time intervals between the x-ray bursts are not unique; the average intervals over the pulsation events were 7.8 and 8.8 sec, respectively. These observations indicate that the pulsation periods in this range are determined by acceleration or pitch-angle redistribution processes in the equatorial plane rather than any fundamental, periodic motion of the electrons along lines of force in the geomagnetic field. (auth)

13318 THE RECOMBINATION COEFFICIENT OF THE NIGHTTIME F LAYER. John S. Nisbet and T. P. Quinn (Pennsylvania State Univ., University Park). J. Geophys. Res., 68: 1031-8(Feb. 15, 1963).

An investigation of recombination in the nighttime F region is described in which use was made of electron-density profiles of the region up to the maximum of the layer obtained from ionosonde records. Several models of

the region above the maximum are compared to reconstruct the entire profile. Profiles of the F layer are reconstructed for several successive hours during the night. The recombination coefficient is then assumed to vary as a function of height in accordance with the scale height of either molecular oxygen or molecular nitrogen, and values of the recombination coefficient at 300 km are calculated. Marked percentage changes of β with temperature, of the same order as current estimates of the changes in neutral-particle density with temperature, are observed. Estimated values of β as a function of temperature are presented. (auth)

13319 SOLAR PROTONS AND MAGNETIC STORMS IN FEBRUARY 1962. A. J. Zmuda, G. F. Pieper, and C. O. Bostrom (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 68: 1160-5(Feb. 15, 1963).

Spatial and temporal variations of solar protons detected during the period Feb. 2-7, 1962 by the satellite Injun 1 are examined. Variations of magnetic intensities, of fluxes, and of magnetic shell parameter are discussed and compared with proton events in July 1961 storms. (D.C.W.)

13320 SOLAR OBSERVATIONS WITH A SOFT X-RAY SPECTROMETER. W. M. Neupert and W. E. Behring (National Aeronautics and Space Administration, Greenbelt, Md.). J. Quant. Spectry. Radiative Transfer, 2: 527-32 (Oct.-Dec. 1962).

A grazing-incidence soft-x-ray spectrometer designed for long-term operation in a satellite is used for preliminary observation of the solar soft x-ray spectrum during a rocket flight. The instrument employs a lightly ruled concave glass grating having a radius of curvature of one meter as the dispersing element. The resultant spectrum is scanned with an open window photomultiplier mounted behind the exit slit on a carriage which moves the assembly along the Rowland circle from 10 to 400 Å. Wavelength calibration is obtained through observation of the carbon K emission band in the laboratory together with observation during flight of the He II Lyman α line. A study of the reflecting power of the grating is made which, together with an investigation of the efficiency of the detector, provides an estimate of the instrumental efficiency at one or more wavelengths. Observations indicate the presence of numerous emission lines in the wavelength region from 120 to 400 Å. Tentative identification of lines produced by highly ionized atoms is made. (auth)

13321 A RELATIVISTIC EFFECT IN LIGHT SCATTERING BY ELECTRONS CAPTURED IN THE VAN ALLEN RADIATION BELTS. G. Calamai (Osservatorio Astrofisico di Arcetri, Florence). Nuovo Cimento (10), 26: 1090-6 (Dec. 1, 1962). (In English)

The intensity of electromagnetic radiation scattered by relativistic electrons is obtained through a Lorentz transformation applied to the Klein-Nishina formula. It follows that the electron scatters in a cone of small aperture around the direction of its velocity. The result is applied to the light- and radiowave-scattering by high-energy electrons trapped in the Van Allen belts. Scattering toward the earth is only possible when the charged particle is inside a small range of magnetic latitude depending on the equatorial pitch. (auth)

13322 CORRELATED CHANGES BETWEEN THE DAILY MEAN INTENSITY AND THE DAILY VARIATION OF COSMIC RAY INTENSITY DURING THE I. G. Y. R. P. Kane (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 27: 14-37(Jan. 1, 1963). (In English)

The problem of correlated changes between daily variation and daily mean intensity of cosmic rays is critically studied. From evidence presented and from that collected by others, it seems that there is no obvious, clear-cut relationship between fluctuations of daily variation and daily mean intensity. During cosmic ray storms, the amplitude of the first harmonic increases at the onset, the hour of maximum being in the afternoon and after a few days the amplitude falls appreciably, the hour of maximum shifting to earlier hours. But this pattern is true only on the average. In individual storms, much more violent and erratic fluctuations of daily variation occur. Also, such fluctuations occur in nonstormy periods as well and are far outside statistical errors. (auth)

13323 A STUDY OF HIGH-ENERGY GAMMA RAYS AT THE TOP OF THE ATMOSPHERE. J. M. Kidd (Univ. of Chicago). Nuovo Cimento (10), 27: 57-85(Jan. 1, 1963). (In English)

Electromagnetic cascades with energy $0.7 \times 10^{11} \leq E_0 \leq 1.2 \times 10^{12}$ ev were investigated in several stacks of nuclear emulsion exposed at an altitude above 100,000 feet for between 7.5 and 15 h. The energies of 96 events were measured by using the shower theory of Kamata and Nishimura. Extended evaluations from the theory were made for cascades initiated by an electron pair and by a single γ ray. The scanning losses were measured and the detector biases calculated in order to determine the absolute intensity of individual γ rays entering the stack at this altitude. The integral energy spectrum of individual γ rays was found to obey a power law with an exponent of $1.9^{+0.3}_{-0.2}$ in the region $0.7 \times 10^{11} \leq E_0 \leq 10^{12}$ ev. The observed angular distribution of individual γ rays at a depth into the atmosphere of ~ 6.5 g/cm^2 could be interpreted by a simple calculation and was found to have no significant energy dependence and to show no indication of a sizable contribution from primary γ rays. The longitudinal development and lateral distribution of these cascades were compared with the average behavior predicted by the shower theory, and the agreement was very satisfactory. (auth)

13324 He^3 NUCLEI IN THE PRIMARY COSMIC RADIATION. F. Foster and J. H. Mulvey (Oxford Univ.). Nuovo Cimento (10), 27: 93-102(Jan. 1, 1963). (In English)

The helium isotopic composition was investigated using a photographic emulsion stack flown from Neepawa, Canada, on August 3, 1958. The proportion of He^3 was determined to be 0.22 ± 0.05 assuming that both isotopes have the same rigidity spectrum. This value is consistent with the assumption that no He^3 is accelerated in cosmic ray sources and the calculated path length in interstellar space is the same as that obtained using the low energy Li, Be, and B flux in the same stack. (auth)

13325 FLUX DENSITY OF PRIMARY COSMIC RAYS AT THE GEOMAGNETIC EQUATOR. G. Kane (Manhattan Coll., New York), R. E. McDaniel, A. G. Barkow, and Z. O'Friel. Nuovo Cimento (10), 27: 107-18(Jan. 1, 1963). (In English)

A stack of nuclear emulsions was kept aloft near the geomagnetic equator by means of a "skyhook" balloon. It remained at an average altitude of 106,500 feet for about 6½ hours. For primaries with atomic number below 6, the method of gap length measurements was used. A twofold criterion of δ-ray and gap measurements was used to identify the atomic number (Z) of each primary cosmic ray for $Z \geq 6$. The following flux values, extrapolated to the top of the atmosphere, were determined for VH-nuclei ($Z \geq 20$) H-nuclei ($Z \geq 10$), and M-nuclei ($6 \leq Z \leq 9$): $J^0_{VH} = 0.10 \pm 0.03$, $J_H = 0.36 \pm 0.05$, and $J_M = 0.57 \pm 0.06$ (particles m^{-2} s^{-1} sr^{-1}). The values of J^0_{VH} and J^0_H are in

good agreement with the values found in the literature. For J_M^0 a wide range of values has been reported. The present value determined for J_M^0 agrees within experimental error with the two lowest values reported by previous investigators. (auth)

13326 PRIMARY COSMIC RAY AND SOLAR PROTONS. [PART] II. Peter Meyer and Rochus Vogt (Univ. of Chicago). Phys. Rev., 129: 2275-9(Mar. 1, 1963).

During July and August, 1961, the energy spectrum of primary cosmic-ray protons was investigated in the energy range from 80 to 350 Mev. The observations were made in five high-altitude balloon flights at geomagnetic latitudes $\lambda \geq 73°N$. Solar flare and quiet day spectra were obtained. A comparison of the 1960 and 1961 results leads to the following conclusions: (1) A significant flux of low-energy protons is continually present in the primary radiation in the years of high solar activity. (2) This flux decreases with the declining level of solar activity as the galactic cosmic-ray flux increases. It is, therefore, suggested that it is of solar origin. (3) The time dependence of the observed proton flux suggests the following alternatives: (a) The particles are produced or released more or less continuously by the sun and do not originate only in the large flare events; or (b) The particles are produced in individual large solar flares and subsequently stored over long periods of time. This second alternative would require a new and as yet unknown storage mechanism with a characteristic time of about 30 or more days. (auth)

13327 EVIDENCE FOR A PRIMARY COSMIC-RAY PARTICLE WITH ENERGY 10^{20} ev. John Linsley (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 10: 146-8(Feb. 15, 1963).

Relations and assumptions used in estimating the size of a cosmic air shower recorded at the MIT Volcano Ranch station are discussed. The total number of particles produced is estimated as 5×10^{10}, and the total energy of the primary particle is estimated as 1.0×10^{20} ev, indicating its origin outside our galaxy. (D.C.W.)

13328 THE INVESTIGATION OF THE SUN'S SHORT-WAVE RADIATION. A. I. Efremov, A. L. Podmoshenskii, O. N. Efimov, and A. A. Lebedev. Planetary Space Sci., 9: 969-76(Dec. 1962).

The investigation was carried out by means of an apparatus installed in the second cosmic satellite. The readings of the apparatus were corrected so as to take into account the difference in disposition of the sun with respect to the field of view of the receiver. Correction factors were introduced on the basis of measurement of the levels of signals on quartz filters In order to determine the flux of energy, it was assumed that the spectral distribution of radiation was in accordance with the law of stability of temperature radiation. (C.E.S.)

13329 NONCOHERENT MECHANISMS OF SPORADIC SOLAR RADIO EMISSION IN THE CASE OF A MAGNETOACTIVE CORONAL PLASMA. V. L. Ginzburg and V. V. Zheleznyakov (Lobachevskii Univ. of Gorkii, USSR). Soviet Astron. AJ (English Transl.), 5: 1-13(July-Aug. 1961).

Noncoherent mechanisms of sporadic solar radio-frequency emission are discussed, with the effect of magnetic field taken into account. The emission is designated conventionally as noncoherent emission when the intensities contributed by discrete particles may be combined additively with reabsorption taken into account, while intensification of waves in the system itself (e.g., in the stream of particles) is negligible. It is shown that noncoherent mechanisms may be held responsible for enhanced radio emission above sunspots, and for type IV and type V solar radio bursts. Solar radio bursts of types I, II, and III cannot be related to noncoherent radio emission of either the synchrotron radiation or the Cherenkov radiation variety. It is also shown that type II and type III bursts may not be related to the noncoherent emission of plasma waves in an isotropic plasma. (auth)

13330 THE INFLUENCE OF COSMIC RAYS ON THE CHARACTER OF MAGNETIC FIELDS AND FILAMENT FORMATION IN THE SHELLS OF SUPERNOVAE. S. B. Pikel'ner (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 5: 14-18(July-Aug. 1961).

Several arguments show that if the pressure of cosmic rays in a system is greater than magnetic forces and gas pressure, the system cannot be in stable equilibrium. The cosmic ray density in the galactic corona cannot be uniform, as this would lead to instability at the boundary where all of the pressure gradient of cosmic rays would then be concentrated. As there should be a cosmic-ray pressure gradient inside the corona, its field cannot be force-free and quasi-regular. Cosmic rays are retained in shells of supernovae and therefore their pressure density is high at the boundary. The main mass of the shell is also concentrated at the periphery. If the field is tangential it creates a peculiar sort of instability, when the field is forced out by cosmic ray pressure in the form of separate loops, and the gas under the action of the acceleration field slides along magnetic lines of force, forming filaments. The curvature of the arcs formed by lines of force between the filaments is evidence of an approximate equality of magnetic and cosmic ray energy. The pressure of cosmic rays can be determined in principle from the condition that it is equal to the pressure in condensations of intersteliar gas within the shell. Such condensations are observed in the source in Cassiopeia. A detailed computation can be made only if photometric data on the spectra are available. (auth)

13331 THE RADIALITY OF CORPUSCULAR STREAMS FROM PLAGES. O. N. Mitropol'skaya. Soviet Astron. AJ (English Transl.), 5: 140-1(July-Aug. 1961).

The question of the radiality of corpuscular streams from plages for the solar activity cycles 16 and 18 is examined. The plages are divided into three groups. In contrast to plages of Group I, the plages of Groups II_u and II_f do not show any distinct dependence. From this the conclusion is drawn that the deviations from radiality of corpuscular streams from plages do not exceed 6°. (auth)

13332 ON THE ORIGIN AND EVOLUTION OF SOLAR FLARES AND THE GENERATION OF COSMIC RAYS IN THEM. V. P. Shabanskii (Moscow State Univ.). Soviet Astron. AJ (English Transl.), 5: 647-50(Mar.-Apr. 1962).

The previously proposed model of a flare as an external manifestation of processes occurring deep in the solar photosphere is improved. A possible mechanism of formation of the soft component ($\epsilon \sim 10^8$ ev) of solar cosmic rays observed before the Forbush decrease is considered. (auth)

13333 POLARIZATION OF RADIATION AND THE STRUCTURE OF MAGNETIC FIELDS IN COSMIC SOURCES OF SYNCHROTRON RADIATION. A. A. Korchakov and S. I. Syrovat-skii (Lebedev Inst. of Physics, Moscow). Soviet Astron. AJ (English Transl.), 5: 678-86(Mar.-Apr. 1962).

The Stokes parameters for radiation emitted by ultra-relativistic particles in a magnetic field have been com-

puted and the connection between the observed polarization, spectral index, and degree of irregularity of the magnetic field of a source were obtained for two particular cases. In the first it is assumed that the magnetic field in the source volume is constant in magnitude but not isotropic. The relation obtained between polarization, spectral index, and anisotropy of the magnetic field is applied to the Crab nebula. This gives estimates of the anisotropy of magnetic pressure in the nebula and the mean field strength from the known acceleration of the expansion of the nebula along its longest axis. In the second case, it is assumed that a uniform external field is superposed on the random magnetic field of the source, which on the average is isotropic. The results obtained can be used for determining the degree of regularity of the magnetic field in the spiral arms of the galaxy from polarization measurements. As the polarization of synchrotron radiation is always governed by the anisotropy of the magnetic field and, consequently, by the anisotropy of magnetic pressure, it can be expected that sources of polarized synchrotron radiation are, as a rule, non-spherical. (auth)

13334 NOVAE AS A POSSIBLE SOURCE OF COSMIC RAYS. E. R. Mustel' (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (English Transl.), 6: 145-53(Sept.-Oct. 1962).

Mechanisms which can lead to the replacement of the premaximum spectrum of a nova by the principal spectrum are considered. This replacement is a universal law for all novae and is evidence for the presence of forces accelerating the ejected gases immediately following light maximum. Previous analysis of this problem is given critical reconsideration. The following accelerating mechanisms of the ejected gases are discussed: (a) shock wave, (b) the acceleration of the detached envelope by gas condensations, which are responsible for the diffuse-enhanced and Orion spectra, (c) radiation pressure. A special study is made of the hypothesis according to which the premaximum and principal spectra are due to the continuous ejection of gases, the intensity and velocity of which vary at light maximum. On the basis of all available spectroscopic and other observational data it is shown that the above mechanisms meet with very serious difficulties and should therefore be rejected. Accordingly it is concluded that the main force P which accelerates the detaching envelope initially at its inner part, is cosmic ray pressure. In this connection it is argued that the "intermediate cavity," which appears (immediately following light maximum) between the detaching argued envelope and the star (commencing to contract) is filled up by cosmic rays. The cosmic ray hypothesis is considered quantitatively. The total energy flux of cosmic rays penetrating into the inner part of the detaching envelope (β-layer) during 1 sec, EN_R, is estimated. The numerical value of this flux is 3.5×10^{42} erg/sec for N Aql 1918 and 6.0×10^{40} erg/sec for N Her 1934. It is adopted that on the average $EN_R \approx 5 \times 10^{41}$ erg/sec for a typical nova. Cosmic ray losses are considered. The two main types of loss are: (a) the acceleration of the detaching envelope and the increase in size of the "intermediate cavity," (b) various inhomogeneities in the principal envelope leading to escape of a fraction of the cosmic rays beyond its boundary (photographs of the nebula surrounding N Per 1901 and other facts). It is estimated that due to inhomogeneities a fraction $\delta \approx 0.1$ of the cosmic rays should escape from the envelope into interstellar space. The interaction between cosmic rays and gases of the detaching envelope with frozen-in magnetic fields is studied. The "output" of cosmic rays into the Galaxy, due to novae, is estimated. It is found that (assuming $\delta \approx 0.1$) in our Galaxy the mean energy of all the cosmic rays due to novae outbursts is $\approx 4 \times 10^{40}$ erg/sec. (auth)

13335 NONSTATIONARINESS OF SPECTRA OF YOUNG SOURCES OF NONTHERMAL RADIO EMISSION. N. S. Kardashev (Shtenberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 6: 317-27 (Nov.-Dec. 1962).

The effect of various modes of energy losses by relativistic electrons on the spectrum of sources of nonthermal cosmic radio-frequency emission is considered, as well as the effect of the systematic and stochastic acceleration of relativistic electrons. Energy spectra are found for various combinations of energy buildup and loss processes, and the time variation of the spectra is studied. The expected synchrotron radiation spectra are obtained, and the variation of these spectra during the evolution of radio sources is investigated. (auth)

13336 ANALYSIS OF THE ALTITUDE DEPENDENCE OF EXTENSIVE AIR SHOWERS FOR DIFFERENT MODELS OF NUCLEAR INTERACTIONS AT HIGH ENERGIES. E. V. Gedalin. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 115-23 (1962). (In Russian)

The altitude dependence of extensive air showers is considered on the assumption that the absolute value of energy transferred to π mesons in nucleon-nucleus collisions at $E > 10^{14}$ ev is constant in the center-of-mass-system. It is shown that to get agreement with the experimental data one must think that secondary interactions of particles different from π mesons carry away the main energy in collisions of nucleons with nuclei, π mesons getting a constant part of the energy of the outgoing particle. (auth)

Criticality Studies

13337 REACTIVITY MEASUREMENT ON THE REFLECTED SEMI-HOMOGENEOUS CRITICAL ASSEMBLY BY PULSED NEUTRON TECHNIQUE. Kenji Sumita (Japan Atomic Energy Research Inst., Tokyo), Yoshihiko Kaneko, Riyosuke Kurokawa, and Tae Wan Park. Nippon Genshiryoku Gakkaishi, 4: 825-34(Dec. 1962). (In English)

Measurements are made of the prompt neutron lifetime and of the equivalent reactivity worths of control rods and the gap between two halves of the SHE-1 (Semi-Homogeneous Critical Assembly Core-1) by pulsed neutron technique. The decay constant α can be measured in the range from 7.19 to 147.7 sec^{-1} within 2.1%. The prompt neutron lifetime of this assembly is determined to be 1.21 ± 0.03 ms (assuming $\beta_{eff} = 0.0067$), and the equivalent reactivity worth of a Cd control rod to be 4.10 ± 0.13 $. However, the reactivity found from the value of α by the conventional formula, $\$ = (\alpha - \alpha_c)/\alpha_c$ is found to have a larger error than experimental one below about − 9 $ for SHE-1, because the change of the value of $k_{eff}\beta_{eff}/l$ with the degree of subcriticality is neglected. The theoretical validity of reactivity measurement in the reflected subcritical system by pulsed neutron technique is discussed. (auth)

Elementary Particles and Radiations

13338 (CEA-2188) ETUDE DE LA VARIATION DE L'EFFICACITE D'UNE SOURCE EMETTRICE α EN

FONCTION DE LA NATURE DU SUPPORT ET DU SEUIL APPLIQUE. (Study of the Variation of the Efficiency of α Emitting Sources as a Function of the Nature of the Support and the Applied Threshold). M. Movchet, M. Boulloud, and Melle Gasc (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 19p.

The effect of the sample holder nature of α sources on their activity measurements was investigated. Preparation of ultra-thin sources (zero-thickness) was attempted and backscattering coefficient for α particles was measured for different sample support materials. (auth)

13339 (JEN-111-DF/I32) ANALISIS GENERAL DE LA DISPERSION. (Scattering General Analysis). A. Galindo Tixaire (Spain. Junta de Energia Nuclear, Madrid). 1962. 69p.

A definition of scattering states is given. It is shown that such states must belong to the absolutely continuous part of the spectrum of the total hamiltonian whenever scattering systems are considered. Such embedding may be proper unless the quantum system is physically admissible. The Möller wave operators are analyzed using Abel- and Cèsaro-limit theoretical arguments. Von Neumann's ergodic theorem is partially generalized. A rigorous derivation of the Gell-Mann and Goldberger and Lippmann and Schwinger equations is obtained by making use of results on spectral theory, wave function, and eigendifferential concepts contained. (auth)

13340 (JINR-E-1114) REGGE POLES AND BETHE-SALPETER EQUATION. B. A. Arbuzov, A. A. Logunov, A. N. Tavkhelidze, and R. N. Faustov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 6p.

An approximate method is suggested for solving equations of the Bethe-Salpeter type and for finding trajectories of the Regge poles. The Bethe-Salpeter equation for scalar particles is taken as an example. (auth)

13341 (JINR-E-1122) REGGE POLES IN QUANTUM ELECTRODYNAMICS. A. A. Logunov, Nguyen Van Hieu, A. N. Tavkhelidze, and A. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 7p.

On the basis of Regge's ideas and the perturbation theory the energy levels of positronium have been obtained. Summation of a certain class of diagrams that is improved by a renormalization group method yields the Regge trajectory from which the levels are determined. (D.C.W.)

13342 (JINR-E-1131) TRACE CALCULATION ON ELECTRONIC COMPUTER. Hans Juergen Kaiser (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 11p.

Calculations of traces of Dirac γ-matrices in evaluation of Feynman diagrams are expedited by a computer program that operates by algebraic means and yields results in closed form. A block diagram of the program calculating trace is given. (D.C.W.)

13343 (JINR-P-1109) KINEMATIKA I GEOMETERIYA LOBACHEVSKOGO. (Kinematics and Lobachevsky's Geometry). Ya. A. Smorodinskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 22p.

The relativistic kinematical problems are formulated in terms of the velocity space with Lobachevsky's metric. The application of a hyperbolic geometry to kinematics is illustrated by some examples. Treatment of the rotation of a top and the kinematics of a particle spin in Lobachevsky's space is shown. The connection between the spin transformation and the parallel displacement in this space is outlined. (auth)

13344 (JINR-P-1124) PROMEZHUTOCHNYE VEKTORNYE MEZONY I RAZNOST MASS K_1^0, I K_2^0 MEZONOV. (Intermediate Vector Mesons and the Mass Difference of K_1^0 and K_2^0-Mesons). Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 4p.

It is shown that the existence of both types of leptonic decays of K^0 mesons with $\Delta S = \pm\Delta Q$ leads to a value for the mass difference of K_1^0 and K_2^0 that exceeds the experimental data by several orders if all the weak interactions are transmitted by one intermediate vector field. The fact that the mass difference of K_1^0 and K_2^0 is small can be accounted for neither by the small constant of the leptonic decays of strange particles, nor by a special choice of the intermediate meson mass. (auth)

13345 (JINR-P-1132) SECHENIYA ROZHDENIYA ANTINUKLONOV. (Cross Sections for Antinucleon Production). V. S. Barashenkov and I. Patera (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 14p.

The available experimental data on the cross sections for antinucleon production in N–N, $\bar{N}$–N, and π–N interactions are discussed. Graphs and tables of data are included. 46 references. (auth)

13346 (JINR-P-1137) NOVAYA FORMULIROVKA STATISTICHESKOI TEORII MNOZHESTVENNOGO ROZHDENIYA CHASTITS. (A New Formulation of the Statistical Theory of Multiple Particle Production). R. Raczka (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 12p.

The angular momentum and momentum conservation in the statistical theory of multiple particle production is taken into account. Convenient formulas for the transition probability have been obtained for the case of peripheral collisions. (auth)

13347 (JINR-P-1138) IZUCHENIE SVOISTV π^0 MEZONOV ROZHDAYUSHCHIKHSYA SO STRANNYNI CHASTITSAMI V π^--p I π^--C VZAIMODEISTVIYAKH. (A Study of Properties of π^0 Mesons Produced with Strange Particles in π^-p and π^-C Interactions). V. A. Belyakov, Yung-chang Wang, N. M. Viryasov, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1962. 11p.

An investigation was performed with a 24-liter propane bubble chamber in a continuation of experiments on strange particle production by 7-8 Bev π^- mesons on hydrogen and carbon. Results are given on the properties of π^0 mesons obtained from the γ quanta accompanying Λ and K^0 production. The specific features of π^0 mesons are compared with those of π^+ and π^- mesons from processes with Λ and K^0 production. A possible existence of resonances with radiative decay is indicated. (auth)

13348 (JINR-P-1141) ROZHDENIE MEZONOV V NEITRINNYKH OPYTAKH I IZOTOPICHESKAYA STRUKTURA SLABOGO VZAIMODEISTVIYA. (Pion Production in Neutrino Experiments and Isotopic Structure of Weak Interactions). Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 5p.

The selection rule $\Delta I = 1$ in strangeness conserving weak interaction processes is shown to lead to relations between the cross sections for pion production by neutrino interactions with protons and neutrons. (auth)

13349 (JINR-P-1149) KVAZIOPTICHESKAYA MODEL I ASIMPTOTIKA AMPLITUDY RASSEYANIYA. (A Quasi-optical Model and Asymptotic Behavior of Scattering Amplitude). B. A. Arbuzov, A. A. Logunov, A. N. Tavkhelidze, R. N. Faustov, and A. T. Filippov (Joint Inst. for Nuclear Research, Dubna. Lab. of Theoretical Physics). 1962. 4p.

Regge asymptotic behavior is shown to hold in the quasi-optical approach to the quantum field theory for the scattering amplitude. (auth)

13350 (JINR-P-1152) POLYUSA REDZHE I ASIMPTOTICHESKOE POVEDENIE SECHENII NEKOTORYKH PROTSESSOV SLABOGO VZAIMODEISTVIYA. (Regge Poles and Asymptotic Behavior of the Cross Sections for Some Weak Interaction Processes). Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 7p.

The asymptotic behavior of the cross sections for some inelastic weak interaction processes has been considered by assuming the existence of the vacuum Regge poles with $\alpha(0) = 1$. It has been shown that in the universal V–A theory of weak interaction the cross section for the production of a π-meson from a neutrino may increase quicker at high energies than the cross section for elastic processes. (auth)

13351 (NP-12514) THEORY OF LOW ENERGY NUCLEON-NUCLEON SCATTERING. IV. NUMERICAL RESULTS FOR HIGH PARTIAL WAVES ($l \geq 2$). D. Amati, E. Leader (European Organization for Nuclear Research, Geneva), and B. Vitale (Rome. Universitâ. Istituto di Fisica and Italy. Istituto Nazionale di Fisica Nucleare, Rome). Aug. 30, 1962. 68p.

The numerical results of a dispersive theory for nucleon-nucleon scattering developed in previous papers are presented for d and higher waves. Phase parameters as function of the energy are given up to 400 Mev. The ingredients of the theory that evaluates the 2π exchanges are amplitudes and parameters that are obtained from the theoretical analyses of simpler processes (π-N scattering, nuclear electromagnetic form factor, etc.). Of these ingredients, those describing the low waves (s and p) $N\bar{N} \to \pi\pi$ amplitudes are, at present, the least reliable. Therefore, the results are presented in two ways: one containing all contributions except for the s and p $N\bar{N} \to \pi\pi$ amplitudes to be added when a better theoretical knowledge of them is available, the other introducing the $N\bar{N} \to \pi\pi$ s and p waves through some phenomenological models based on the Bowcock, Cottingham, and Lurié analysis of π-N scattering. The effect of the ω is also tentatively introduced. These last results are compared with the phase parameters obtained from experimental data: the agreement is encouraging for one of the models used up to about 250 Mev both for $T = 0$ and $T = 1$ phase parameters. (auth)

13352 (NYO-10242) INTERACTION CONTRA CLASSICAL RELATIVISTIC HAMILTONIAN PARTICLE MECHANICS. Douglas G. Currie (Rochester, N. Y. Univ.). Dec. 4, 1962. Contract AT(30-1)-875. 61p.

The relativistic hamiltonian formalism (relativistic generator formalism) is outlined and discussed for classical particles. The implications of the requirement that the coordinates of an event transform according to the Lorentz transformation law are discussed and expressed in a form, called the world line conditions, that may be considered in the relativistic hamiltonian formalism. It is then shown that the world line conditions imply that there is no interaction in the relativistic hamiltonian formalism; that is, the motion of any pair of particles described by the relativistic hamiltonian formalism consists of straight line motion. In other words, if the events that compose the world lines of the particles transform according to the Lorentz transformation law, and the path of the particle is not a straight line, then this phenomena cannot be described in terms of a relativistic two-particle hamiltonian formalism. The experimental basis for a determination of the transformation properties of an event is considered, and the relation of the experiment to the applicability of such a formalism is discussed. (auth)

13353 (RM-2936-ARPA) THE PROBABILISTIC METHOD FOR PROBLEMS OF RADIATIVE TRANSFER: THE MARKOV PROPERTY OF RADIATIVE TRANSFER AND OF NEUTRON DIFFUSION. Sueo Ueno (RAND Corp., Santa Monica, Calif.). Feb. 1962. Contract SD-79. 20p. (AD-278466, N62-10428).

A Markovian stochastic model of multiple scattering of photons is constructed for consideration of the diffuse reflection and transmission of a parallel radiation beam by a finite, plane-parallel, non-emitting, homogeneous atmosphere with conservative and isotropic scattering. On assumption of homogeneous stationary evolution with respect to depth, forward and backward integro-differential equations for the emission probability distribtuions are derived from the appropriate Chapman-Kolmogoroff equations. Starting with Laplace transformations of these equations, the scattering and transformation functions dependent on the optical depths are obtained. Optical homogeneity of the medium makes results of the forward equations equal those of the backward equations. Therefore, diffuse reflection and transmission of parallel rays by a finite atmosphere represents a Markovian evolutionary process reversible with respect to optical depth. 21 references. (D.C.W.)

13354 CALCULATION OF FISSION NEUTRON SPECTRA EMITTED AT ANGLES OF 0°, 45°, AND 90° TO THE LINE OF FLIGHT OF THE FRAGMENTS. E. I. Sirotinin. At. Energ. (USSR), 13: 530-3(Dec. 1962). (In Russian)

It was established previously that spectra of neutrons emitted under angles of 0, 45, and 90° to their line of flight yield better data concerning the formation of the fission neutrons than spectra measured without reference to the direction. Therefore, the preliminary data obtained by Yu. A. Vasil'ev et al. (Atomnaya Energiya, 9: 449(1960) No. 6) on the basis of the evaporation model, was recalculated as proposed by J. Terrell (Phys. Rev., 113: 527(1959), assuming that the neutrons are emitted isotropically within the coordinate system of a given fragment. The results of this calculation were found to agree well with Vasil'ev's experimental data, confirming the theory that evaporation from excited fragments is the probable mechanism of the formation of fission neutrons. However, no definite conclusions could be drawn on the anisotropy of the neutron emission by the fragments. (TTT)

13355 ABSORPTION OF γ-RADIATION IN INFINITE LATTICE ARRAYS. B. M. Terent'ev, V. A. El'tekov, and Yu. S. Ryabukhin. At. Energ. (USSR), 13: 568-71(Dec. 1962). (In Russian)

An attempt was made to answer the question of the applicability of the Fermi-age approximation for homogeneous and heterogeneous media by making Monte Carlo computations and evaluating the results obtained. The distribution of absorbed energy of γ radiation between the sources forming an infinite lattice was compared with the energy absorbed in the surrounding medium, using the "Strela" computer for the calculations. Experimental data obtained with In–Ga irradiators and the telescoping fuel elements

of the IRT reactor were used for calculating the distribution of the absorbed energy of the radiation. The irradiated surrounding medium consisted of water in both cases. It was concluded that the age approximation method may be used for infinite quasi-homogeneous systems. Good results were obtained also when the requirement of quasi-homogeneity was not clearly fulfilled, making it thus possible to avoid the Monte Carlo calculations. (TTT)

13356 SPECTRA OF NEUTRONS EMITTED BY Po–Be AND Ra–Be SOURCES. L. Medveczky (Inst. of Nuclear Physics, Hungarian Academy of Sciences, Debrecen). At. Energ. (USSR), 13: 583-7(Dec. 1962). (In Russian)

In a previous publication of the author (Acta Phys. Hung., 6: 261(1956)) on the energy distribution of neutrons emitted from a Po–Be source, the thick-target spectrum, corresponding to the $Be^9(\alpha,n)C^{12}$ reaction, was examined. The measurements were repeated, making use of other sources prepared with and without carrier. The peak energies (at 3.1, 4.2, 4.8, 6.4, and 7.4 Mev) agreed quite well with the previous findings but the ratio of neutron intensities >6 Mev/<6 Mev differed considerably. The repeated measurements revealed more than 10 peaks in the continuous spectrum. A larger number of tracks were recorded during the study of the neutron energy distribution of Ra–Be source than reported by other authors; the neutron intensity was found to be lower than the value given by J. DePangher (HW-56199 (1958)). (TTT)

13357 A RESOLUTION OF THE SCATTERING EQUATION OF ELECTRONS IN AN ION SOURCE WITH HIGH FREQUENCY ELECTRICAL EXCITATION AND INDUCTIVE COUPLING. Daniel Blanc and André Degeilh (Centre National de la Recherche Scientifique, Toulouse). Compt. Rend., 255: 2408-10(Nov. 5, 1962). (In French)

The scattering equations of electrons in the cylindrical ionization chamber of the source is solved. In the case where the continuous electrical field parallel to the axis of revolution is super-imposed, the expression of the product $n\underline{D}(\underline{n}$ is the electron density and D is the scattering coefficient) is established for the case where the "ionization functions" ν_i/D is of the form Ar^2 (ν_i is the ionization frequency per electrons, r is the distance to the axis of revolution and A is a constant). (tr-auth)

13358 THEORY OF RESONANCES CONSIDERED AS INTERNAL EXCITED STATES OF THE RELATIVISTIC ROTATOR MODEL OF ELEMENTARY PARTICLES. Pierre Hillion and Jean-Pierre Vigier. Compt. Rend., 255: 2566-7(Nov. 12, 1962). (In French)

The relativistic rotator model of elementary particles developed recently admits theoretically an infinity of internal quantum levels which correspond to stable or metastable internal excited states. This implies that besides the particles observed (associated by hypothesis to the lowest levels) new levels can be predicted which are tentatively identified with recently observed resonances. A preliminary discussion is given independently of the particular choice made to classify the baryons and bosons in the model. (tr-auth)

13359 PARTICLE SYMMETRIES. Yuval Ne'eman. Intern. Sci. Technol., No. 15: 69-70; 72; 74; 76; 80; 82-3 (Mar. 1963).

The present state of strong-interaction theory is one of confusion. However, an approach based on higher symmetries may provide answers. A description is given of this approach. (D.L.C.)

13360 MEAN LIVES OF POSITRONS IN AQUEOUS SOLUTIONS. Jerome E. Jackson and John D. McGervey (Western Reserve Univ., Cleveland). J. Chem. Phys., 38: 300-3(Jan. 15, 1963).

By measurement of the time distribution of positron annihilations in aqueous solutions, reaction rates for oxidation of positronium (Ps) by the ions MnO_4^-, IO_3^-, and Hg^{2+} were determined. In strong oxidizing solutions, the mean life of the positrons reaches a lower limit of 4.3×10^{-10} sec; the short lifetime τ_1 in water was measured and found to agree with this value. A $Pb(ClO_4)_2 \cdot 3H_2O$ solution reduced the intensity I_2 with no significant change in the long life τ_2, an effect previously observed in nitrate solutions. This may mean that in these two cases oxidation can occur before Ps is thermalized but not afterwards. The decay distributions from a mixture of Hg^{2+} and MnO_4^- ions in solution and the Hg^{2+} ion in separate solutions with Cl^- and ClO_4^- indicated an association taking place between the negative and positive ions. (auth)

13361 EXPECTATION VALUE FORMALISM IN QUANTUM FIELD THEORY. [PART] I. Pradip M. Bakshi and Kalyana T. Mahanthappa (Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 4: 1-11(Jan. 1963).

A formalism has been developed to evaluate the expectation values of projection operators directly. The formalism is applied to the production of particles when the corresponding quantized fields are coupled to external sources and external electromagnetic fields. (auth)

13362 EXPECTATION VALUE FORMALISM IN QUANTUM FIELD THEORY. [PART] II. Pradip M. Bakshi and Kalyana T. Mahanthappa (Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 4: 12-16(Jan. 1963).

The expectation value formalism was developed to treat the problems which require the coupling of quantized Fermi and Bose fields. (auth)

13363 RELATIVISTIC INVARIANCE AND THE SQUARE-ROOT KLEIN-GORDON EQUATION. J. Sucher (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 4: 17-23(Jan. 1963).

Although the usual operator invariance requirements and corresponding commutation conditions encountered in the study of the invariance of relativistic wave equations (and other equations of physics) are sufficient conditions for invariance, they are by no means necessary. More general conditions are given and illustrated with the square-root Klein-Gordon equation. A new proof is thereby given of the Lorentz invariance of this equation. The methods developed are extended to cover the presence of external fields, and it is proved that the usual gauge invariant modification of the relativistic Hamiltonian of a spinless particle which takes into account the presence of an external electromagnetic field leads, in the quantum mechanical case, to an equation which does not admit the proper Lorentz group. This theorem and its generalization are discussed in connection with Dirac's statement that the square-root equation cannot be extended to include interaction without losing Lorentz invariance. (auth)

13364 A SUMMATION PROCEDURE FOR CERTAIN FEYNMAN INTEGRALS. Donald G. Babbitt (Aerospace Corp., El Segundo, Calif. and Univ. of California, Los Angeles). J. Math. Phys. (N. Y.), 4: 36-41(Jan. 1963).

A mathematically rigorous summation procedure is developed for Feynman integrals involving a repulsive potential. The central idea of the proof is to connect certain Wiener integrals with the Feynman integral in question by making use of holomorphic vector-valued functions and holomorphic semigroups. (auth)

13365 LOW-ENERGY EXPANSION OF SCATTERING PHASE SHIFTS FOR LONG-RANGE POTENTIALS. Bertram R. Levy and Joseph B. Keller (New York Univ. New York). J. Math. Phys. (N. Y.), 4: 54-64(Jan. 1963).

Phase shifts can be used to describe the quantum mechanical scattering of a particle by a spherically symmetric potential. They are odd functions of the wave number k, which is proportional to the square root of the energy of the incident particle. For short-range potentials, they are analytic at $k = 0$ and can be expanded in odd powers of k. However for long-range potentials they are not analytic at $k = 0$ so they cannot be expanded in powers of k. Since electron-atom, atom-atom, proton-neutron, and multipole-multipole potentials are of long range, it is important to consider such potentials. A method is presented for determining the appropriate expansions around $k = 0$. The method is applied to potentials which are $O(r^{-\nu})$ as $r \to \infty$, and the phase shifts for any angular momentum are obtained up to and including the first nonanalytic term. For $L = 0$ and $3 < \nu < 4$ the next term is also obtained. The nonanalytic terms involve ln k and fractional powers of k. The results for $\nu = 4$ and the k dependence for $\nu = 2L + 3$ agree with those obtained in a different way by O'Malley, Spruch, and Rosenberg. The method involves a function $\eta(r)$ whose asymptotic value $\eta(\infty)$ is the desired phase shift. A nonlinear first-order ordinary differential equation is derived for $\eta(r)$. This equation is solved by expansion and iteration methods. To expand the solution around $k = 0$, two simple theorems are proved concerning the asymptotic forms of certain integrals containing a parameter. (auth)

13366 THE INVERSE PROBLEM IN THE QUANTUM THEORY OF SCATTERING. L. D. Faddeyev. J. Math. Phys. (N. Y.), 4: 72-104(Jan. 1693). (Translated by B. Seckler from the Russian).

This report is a translation from the Russian of a survey article by L. D. Faddeyev, which appeared in Uspekhi Matem. Nauk., 14: 57(1959). Our own interest in this article lies in its relevance to the inverse scattering problem—that is, the problem of determining information about a medium from which an electromagnetic wave is reflected, given a knowledge of the reflection coefficient. Similar questions concerning scattering phenomena in other branches of physics, e..g, in quantum mechanics, can be investigated by means of the same theory. (auth)

13367 THE $\bar{K}N$ RESONANCE AT THE $\bar{K}^*N$ THRESHOLD. Chia Hwa Chan (Imperial Coll. of Science and Tech., London). Nucl. Phys., 39: 220-38(Dec. 1962). (In English)

Damping theory of $\bar{K}^*$ production in $\bar{K}N$ collisions and its effect on the $\bar{K}N$ resonance at 1 Bev/c are fully investigated. To make the calculation possible, the $\bar{K}^*$-meson is assumed to be stable and the one-pion-exchange is taken as the only contribution to the left hand cut. It is found that a resonance can be produced in the $\bar{K}N$ system in the D_3, $I = 0$ state when $\bar{K}^*$ is taken as a vector meson. (auth)

13368 TALMI TRANSFORMATION FOR PARTICLES WITH DIFFERENT MASSES. [PART] II. Yu. F. Smirnov (Moscow State Univ.). Nucl. Phys., 39: 346-52(Dec. 1962). (In English)

A simple method is offered for calculating the Talmi coefficients for particles with different masses by passing to cartesian coordinates. (auth)

13369 THE NON-MESIC INTERACTIONS OF K^- MESONS IN DEUTERIUM. E. H. S. Burhop, A. K. Common, and K. Higgins (University Coll., London). Nucl. Phys., 39: 644-57(Dec. 1962). (In English)

The Chew-Low virtual target method is adapted to the calculation of the transition rate for non-mesic capture processes of K^- mesons in a mesic deuterium atom. Numerical calculations of these transition rates are carried out using the complex scattering lengths for K^--nucleon interactions derived by Ross and Humphrey from the studies made by the Alvarez group of K^- capture in a liquid hydrogen bubble chamber. Rates for K^- mesic transitions in deuterium are also calculated. The corresponding calculated branching ratio for K^- non-mesic transitions is of the observed order of magnitude. The possibility of using measurements of the non-mesic K^- transition rate in heavier nuclei for the study of nuclear correlations is briefly discussed. (auth)

13370 BOUND STATES AND DISPERSION RELATIONS IN A MODEL FIELD THEORY. Leonard M. Scarfone (Florida State Univ., Tallahassee). Nucl. Phys., 39: 658-66(Dec. 1962). (In English)

The eigenvalue condition for the V + N potential in a trivially modified Lee model is developed with the methods of dispersion theory. The problem is exactly soluble and shows in a simple example how certain vertex functions enable one to calculate the eigenvalue condition in agreement with that obtained by standard techniques. (auth)

13371 K-π RESONANCE AND THE STRANGENESS VIOLATING WEAK INTERACTIONS. Sadao Oneda, Shin Chiba, Shoichi Hori, and Hiromichi Hiraki (Kanazawa Univ., Japan). Nucl. Phys., 39: 667-79(Dec. 1962). (In English)

It is pointed out that for the p-wave K-π resonance M, comparison of the rates of $K^+ \to e + \nu + \pi^0$ and $M^+ \to K^+ + \pi^0$ decays could provide us with useful information with respect to the value of the coupling constant of strangeness violating weak interactions and also to that of strong interaction of M. The results are consistent with the experimentally found low rate of $\Lambda \to p + e^- + \nu$ decay and also with the sharp backward peaking of the Λ^0 in the reaction $\pi^- + p \to \Lambda^0 + K^0$ with high incident pion energy. The effects of the K-π resonances on the $K \to e + \nu + \pi$ decay are discussed and it is inferred that these effects are not important. The status of the strangeness violating weak interaction is discussed. (auth)

13372 SPINOR FIELDS IN GENERALLY COVARIANT THEORIES. A. Peres (Israel Inst. of Tech., Haifa). Nuovo Cimento (10), 24: Suppl. No. 2, 389-452(1962). (In English)

Classical field theory was investigated. The Lagrangian was a function of one or several spinor fields, of an affine connection, of their complex conjugates, and of a Hermitian metric spinor. No restriction was put on the functional form of the Lagrangian, except for the usual requirements of reality and of invariance under coordinate or spin transformations. The Lagrangian was also treated in the absence of spinor fields. The field equations then went over to the Maxwell-Einstein equations. The neutrino field was introduced and the affine connection was shown to be no longer Riemannian. The non-Riemannian part of the connection was related to the neutrino current. The gravitational field of the Dirac particles was approached by a straightforward generalization of the results for the neutrino field. The theory was generalized so as to include scale transformations. (C.E.S.)

13373 PERIPHERAL MODEL FOR INELASTIC PROCESSES. E. Ferrari and F. Selleri (CERN, Geneva). Nuovo Cimento (10), 24: Suppl. No. 2, 453-515(1962). (In English)

Predictions obtained when inelastic processes are described in terms of a dominant peripheral interaction are

discussed in detail. The case of three particles in the final state is considered. The peripheral model is used to obtain complete predictions for the angular and energy distributions of the final particles. These considerations are extended to the case of an arbitrary number of particles present in the final state. (C.E.S.)

13374 RECENT EXPERIMENTAL INFORMATION ABOVE 3 Gev. G. von Dardel (CERN, Geneva). Nuovo Cimento (10), 25: Suppl. No. 2, 77-87(1962). (In English)

A review of some of the work done during the last year in the energy range above 3 Bev is given. With the CERN 28-Bev proton synchrotron and a corresponding machine at Brookhaven, it has become possible to perform accurate experiments in this energy range. Work in total cross sections, elastic differential cross sections, quasi-elastic scattering and highly inelastic collisions is reviewed. (C.E.S.)

13375 THEORY OF HIGH-ENERGY SCATTERING AND MULTIPLE PRODUCTION. D. Amati (CERN, Geneva), A. Stanghellini, and S. Fubini. Nuovo Cimento (10), 26: 896-954(Dec. 1, 1962). (In English)

A theoretical model is proposed for the high-energy interaction, the basic idea of which is that the high-energy processes are reducible to the low-energy ones through a peripheral mechanism. The asymptotic properties of this model are studied by means of a linear homogeneous integral equation, whose kernel depends on the low-energy amplitudes. It is shown that many general predictions can be derived that are independent of the detailed form of the low-energy input. The results refer both to high-energy elastic scattering and multiple production. For the inelastic processes, simple general predictions are found for measurable quantities such as multiplicities, inelasticity, and spectra of secondaries. For the elastic scattering, the characteristic Regge pole behavior is found for all scattering amplitudes. The relation between the bound-state problem and diffraction can therefore be understood in a relativistic model, which contains in itself both phenomena. The possible corrections of the model are discussed, by using approximately the unitarity condition. Indications are found of the possible existence of continuous power distribution, or equivalent of cuts in the complex angular-momentum variable. (auth)

13376 OPERATOR EQUATIONS FOR FOLDY-WOUTHUYSEN TRANSFORMATIONS. F. Strocchi (Università, Pisa, Italy). Nuovo Cimento (10), 26: 955-73 (Dec. 1, 1962). (In English)

The one-particle Hamiltonians Ω_+ and Ω_-, introduced for charged scalar fields in a static electromagnetic field, are derived by diagonalizing the matrix Hamiltonian that is at the basis of a particular formulation of wave mechanics of spin-zero particles. The analogous problem for spin-one particles in a static electromagnetic field is also discussed. (auth)

13377 PROOF OF DISPERSION RELATIONS AND UNITARITY OF THE S-MATRIX. Y. S. Jin (CERN, Geneva). Nuovo Cimento (10), 26: 974-97(Dec. 1, 1962). (In English)

The proof of the dispersion relation is extended to high momentum transfer by making use of the unitarity of the S matrix for the energy region below the threshold for three-particle states. For the pion-nucleon scattering, the dispersion relation can be proved up to the momentum transfer $\Delta^2 < 4.7\ \mu^2$. An integral representation is applied explicitly to the final expression of the absorptive part. (auth)

13378 HIGHER SYMMETRIES AND POMERANČUK CONDITIONS. D. Amati, J. Prentki, and A. Stanghellini (CERN, Geneva). Nuovo Cimento (10), 26: 1003-9(Dec. 1, 1962). (In English)

A general method is given, which allows the determination of the number of independent total cross sections at high energies in the framework of a group of symmetry, under specified conditions. (auth)

13379 DECAY RATES OF THE ω-MESON AND γ-3π INTERACTION. K. Kawarabayashi (Tokyo Univ.) and A. Sato. Nuovo Cimento (10), 26: 1017-28(Dec. 1, 1962). (In English)

Relations among various effective coupling constants involved in the decay processes of the ω and ρ mesons are studied, in connection with an attempt to estimate the strength of the γ-3π interaction. The amplitude H, which characterizes the strength of the γ-3π interaction, is shown to be smaller by a factor of 2 or 3 than the result calculated by perturbation theory in order to reproduce the observed decay rate of the neutral pion. Rates of rare decay modes of the ω and ρ mesons are calculated explicitly in terms of the decay rate of the process $\omega \rightarrow \pi^+ + \pi^- + \pi^0$. It is pointed out that the two-peak structure of the process $\rho_0 \rightarrow \pi^+ + \pi^-$ observed in the nucleon pair annihilation can be explained by the rare decay mode $\omega \rightarrow \pi^+ + \pi^-$, if the width of the process $\omega \rightarrow 3\pi$ turns out to be smaller than 1 Mev. In this case the process $\rho \rightarrow 3\pi$ is able to compete with the process $\omega \rightarrow 3\pi$. (auth)

13380 DYNAMICAL EQUATIONS AND ANGULAR MOMENTUM. V. De Alfaro, T. Regge, and C. Rossetti (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 26: 1029-62(Dec. 1, 1962). (In English)

Potential scattering is described in terms of functions $F(\lambda,s)$ of the variables λ (angular momentum) and s (energy). In particular, the connection is discussed between analytic properties of $F(\lambda,s)$ and the double dispersion relation plus unitarity for the transition amplitude. It is found that all these properties can be condensed into an integral representation for $F(\lambda,s)$ and a nonlinear identity. From this identity and the integral representation, it is possible to construct $F(\lambda,s)$. The advantage of working on the mass shell is paid for by the nonlinearity of the equations. It should be pointed out that in this method there are no subtraction troubles, and that it is possible to determine the location of bound states and resonances. (auth)

13381 NEUTRON-PROTON MASS DIFFERENCE. L. K. Pande (Brandeis Univ., Waltham, Mass.). Nuovo Cimento (10), 26: 1063-5(Dec. 1, 1962). (In English)

It is shown that using dispersion-theoretical formulas for the electromagnetic self-energies of the nucleons, which formulas involve their electromagnetic form factors, the mass difference between the neutron and the proton can be explained. The expressions for the form factors involved require two cut-offs, which are at about 3 and 5 nucleon masses. (auth)

13382 GENERALLY COVARIANT DIRAC EQUATION AND ASSOCIATED BOSON FIELDS. H. Leutwyler (Universität, Bern). Nuovo Cimento (10), 26: 1066-89(Dec. 1, 1962). (In English)

The equation of the classical formalism of covariant spinor analysis, wherein the field of the affine connection in spinor space $\Gamma_\mu(x)$ is fixed by $D_\mu\gamma_\nu = 0$, is rejected. By a closer analogy to tensor analysis in metric space, only reality conditions are found to be imposed on $\Gamma_\mu(x)$, with considerable independent dynamical freedom remaining. Starting with a variational principle, a nonlinear wave equation with nonvanishing rest mass is obtained for the affine field $\Gamma_\mu(x)$, whose structure is dictated by invariance

requirements. As particular examples, Maxwell's equations and the pseudoscalar meson-nucleon interaction are discussed, in addition to Heisenberg's nonlinear spinor equation. (auth)

13383 CONTRIBUTION TO THE THEORY OF ACCIDENTAL DEGENERACIES. L. J. Weigert and M. E. Rose (Univ. of Virginia, Charlottesville). Nuovo Cimento (10), 27: 38-56(Jan. 1, 1963). (In English)

An attempt is made to throw light on the problem of degeneracies that cannot be simply attributed to self-evident symmetry properties of a physical system. The investigation is based on a hamiltonian that contains two independently continuously variable parameters that enter in a linear way when the operator form of the energy is constructed. The hamiltonian may therefore contain as many as two independent terms that must commute plus a perturbation $\zeta H'$. Emphasis is placed on the question of conditions whereby degeneracies in the unperturbed problem are removed for any perturbation over at least a finite range of ζ. Such points, acnodes in parameter space, are found to occur, in general, only for $\zeta = 0$. The fact that such situations arise for uncoupled levels is clearly nontrivial. From a study of the nature of the degeneracies, as they depend on the parameters, between uncoupled states in cases of special dimensionality of the set of coupled states, one can conclude that acnodes are not often encountered and usually, a degeneracy in the unperturbed case will persist in the sense that it will occur for a continuous manifold of points in parameter space. It is pointed out that degeneracies may exist that are independent of the values of the parameters. These so-called intrinsic degeneracies are discussed in an appendix. (auth)

13384 A NOTE ON THE EFFECTS OF MULTI-PION RESONANCES FOR ELECTRON-POSITRON COLLIDING BEAM EXPERIMENTS. K. Kawarabayashi (Tokyo Univ.) and A. Sato. Nuovo Cimento (10), 27: 103-6(Jan. 1, 1963). (In English)

The total cross section for electron-positron annihilation into three pions is calculated with the inclusion of effects of multi-pion resonances (ρ and ω meson). The result shows that the perturbation calculation is appreciably modified by the effects of these resonances. A marked peak of the cross section is expected to appear around $E_{c.m.} \approx 400$ Mev with a magnitude of the order of few μb. (auth)

13385 THE EFFECT OF A PION-PION INTERACTION ON LOW-ENERGY PION-NUCLEON SCATTERING. K. Dietz (Technische Hochschule, Karlsruhe, Ger.). Nuovo Cimento (10), 27: 141-8(Jan. 1, 1963). (In English)

In the present paper we start from the Mandelstam representation for π-N scattering and give equations for the partial-wave amplitudes which differ from similar relations by CGLN in the following ways: a) the projection on the partial-wave amplitudes is carried out exactly; b) the dependence on the nucleon mass is also taken into account exactly; c) CGLN consider only the contribution of the first π-N resonance to the dispersion integral. We avoid a large part of this approximation by subtracting the (J = T = 1) $\pi + \pi \rightarrow N + N$ amplitude which can be computed approximately from the Q-resonance data and the total π-N cross sections. The accuracy of the method is tested quantitatively by comparison with the forward scattering dispersion relation. S, P, D π-N partial waves are calculated. S-waves up to about 100 Mev can be predicted practically without fitting free parameters. The predictions should hold fairly well up to about 200 Mev. (auth)

13386 PRODUCTION OF STRANGE PARTICLES IN PROTON-NEUTRON COLLISIONS. W. D. Curtis (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 27: 164-77(Jan. 1, 1963). (In English)

Strange particle production in proton-neutron collisions is calculated by means of the one-pion exchange (O.P.E.) model for an incoming neutron with a kinetic energy of 3 Bev in the laboratory frame. The calculation takes into account two Feynman diagrams and includes the interference term. Use is made of the Ferrari-Selleri cut-off function $C(\alpha,q^2)$ and these results are compared with those that do not take this into account. The lab. energy spectra of the outgoing nucleons are drawn for the six(p,n) processes, and their total cross sections evaluated. From these results the total cross-section values for the four corresponding (p,p) reactions are deduced and compared with their known experimental values at 2.85 Bev. Good agreement is shown in three of these cases, but the theoretical result for the fourth one is somewhat small. (auth)

13387 PARTIAL SUMMATION OF THE PERTURBATION EXPANSION IN HIGH-ENERGY QUANTUM ELECTRODYNAMICS. K. E. Eriksson (Univ. of Upsala). Nuovo Cimento (10), 27: 178-92(Jan. 1, 1963). (In English)

The renormalization group method is applied to the perturbation expansion of electromagnetic scattering cross sections at high momentum transfer. It is shown that the limit of vanishing electron mass exists for high momentum transfer and high normalization momentum. In this limit the functional equations of the renormalization group provide a means to sum over maximally logarithmic terms to all orders starting only from the knowledge of the lowest order radiative corrections. The summation over soft particle emission which is included here, contains not only soft photons but also soft electron pairs. The summation over the soft photon emission is performed with an accuracy somewhat better than that provided by the renormalization group method. The terms that remain after the summation over maximally logarithmic terms and soft particle emission are of the relative order $(\alpha/\pi)^2 \ln (q^2/m^2)$ and $(\alpha/\pi)\,\Delta E/q$, where m is the electron mass, q is the momentum transfer and ΔE is the experimental energy resolution. It is also found that in high-energy scattering the one-photon exchange strongly dominates over the exchange of several photons except for nearly forward or backward scattering in the c.m. system. (auth)

13388 ANALYSIS OF PHOTOPRODUCTION WITH AN ISOBARIC MODEL. M. Gourdin (CERN, Geneva) and Ph. Salin. Nuovo Cimento (10), 27: 193-207(Jan. 1, 1963). (In English)

An analysis of the photoproduction of π mesons on nucleons was made with the aid of a model where the isobars simulate the interaction in the final state. Results relative to the isobar $J = \frac{3}{2}^+$ are discussed. Agreement with experiment can be found with a small electric transition $E_1^+/M_1^+ = -0.045$ and without contributions of terms due to π-π interaction. The small part played by the electric quadrupole permits the explanation of recent experiments on photoproduction of π^0 carried out with polarized photons. (tr-auth)

13389 LARGE-ANGLE ELASTIC SCATTERING AT HIGH ENERGIES TREATED BY A STATISTICAL MODEL. G. Fast and R. Hagedorn (CERN, Geneva). Nuovo Cimento (10), 27: 208-17(Jan. 1, 1963). (In English)

An analysis is made of the contribution of the not too peripheral collisions to large-angle elastic scattering. This type of collision—which is supposed to give the main

contribution to the large-angle elastic scattering—is assumed to be well described by the statistical model, which then can predict the weight of the elastic channel as compared to all channels. Therefore, the ratio $\sigma_{el}/\sigma_{inel}$ can be calculated for all angles lying sufficiently outside the diffraction peak. Graphs are given for the ratio $\sigma_{el}/\sigma_{inel}$ for πN and NN scattering up to 25 Bev primary energy together with the corresponding graphs for the transformation of the angle between the center of momentum and the laboratory system. The non-diffractive elastic cross section decreases (according to the statistical model) roughly exponentially with increasing total energy in the c.m. system. (auth)

13390 GENERATION OF "BEATS" FROM A MICROSCOPIC VIEWPOINT. Z. Fried and W. M. Frank (Naval Ordnance Lab., Silver Spring, Md.). Nuovo Cimento (10), 27: 218-27(Jan. 1, 1963). (In English)

The microscopic mechanism for producing photons of frequency $\nu_1-\nu_2$ out of a mixture of beams of photons with frequencies ν_1, ν_2 in the presence of charged particles is explained. The generation of the beat frequency photons can be understood as the absorption of a photon of frequency ν_1 by the electron and enhanced induced emission of a photon of frequency ν_2 and another photon of frequency $\nu_1-\nu_2$. This nonlinearity can manifest itself in a free electron gas. Production rates for freely propagating charged particles are presented, and the relevant matrix elements for bound electrons are discussed. (auth)

13391 SPECULATIONS ON μ-MESON FORM FACTORS. K. J. Barnes (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 27: 228-37(Jan. 1, 1963). (In English)

A formula for the elastic electromagnetic interaction of two spin-$\frac{1}{2}$ particles with structure is given in terms of covariant variables, and this formula is then used to calculate the differential cross section for the scattering of μ mesons by protons. An attempt is made to discover what evidence of any possible μ meson structure can be obtained from such experiments, and some of the difficulties involved are discussed. (auth)

13392 SINGLE-PION PRODUCTION IN π^+-p COLLISIONS AT 820, 900 AND 1050 Mev. R. Barloutaud, J. Heughebaert, A. Levèque, C. Louedec, J. Meyer, and D. Tycho (Centre d'Etudes Nucléaires, Saclay, France). Nuovo Cimento (10), 27: 238-50(Jan. 1, 1963). (In English)

Experimental results on inelastic scattering of π^+-p, at 820, 900, and 1050 Mev kinetic incident energies are analysed in terms of isobaric and $\pi\pi$ models. They are in agreement with a dominant formation of $\frac{3}{2}\frac{3}{2}$ isobar although some deviations from the isobaric model predictions are observed. Particularly, some evidence for ρ and ζ mesons are presented. However no definite conclusion concerning the ζ can be drawn. (auth)

13393 A NOVEL APPROACH TO ELEMENTARY SCATTERING THEORY. F. Calogero (Univ. of California, Berkeley). Nuovo Cimento (10), 27: 261-302(Jan. 1, 1963). (In English)

An approach to potential scattering is discussed, which is simple, elegant, and very convenient for numerical computations. The problem of evaluating scattering phase-shifts and bound-state energies is discussed. The effect of the potential on the wave function is also analysed. Approximating formulas are given. A powerful representation for the tangent of the phase shift, valid if the potential never changes sign and the phase shift is smaller in magnitude than $\pi/2$, is obtained. Bounds on the phase shifts and on their derivatives with respect to linear and angular momentum are established. (auth)

13394 STOCHASTIC FIELD THEORY: THE S-MATRIX. R. L. Ingraham (New Mexico State Univ., University Park). Nuovo Cimento (10), 27: 303-5(Jan. 1, 1963). (In English)

A modified definition of the stochastic S-matrix ensemble $\{S(L)\}$ was given. It had only finite matrix elements in any order, was unitary, and seemed to satisfy all other requirements. (C.E.S.)

13395 DETERMINATION OF THE $\gamma\pi\rho$ COUPLING CONSTANT FROM A DOUBLE PHOTOPRODUCTION EXPERIMENT. W. Alles and D. Boccaletti (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 27: 306-8(Jan. 1, 1963). (In English)

An analysis of a double photoproduction experiment was performed to test the validity of the peripheral model. From this model the decay made of the ρ-meson can be calculated. Another application is the calculation of the π lifetime and the determination of the $\gamma\pi\rho$ coupling constant. (C.E.S.)

13396 SOME REMARKS ABOUT GAUGE INVARIANCE IN THE ISOBARIC MODEL FOR PHOTOPRODUCTION. M. Gourdin (Laboratoire de Physique Théorique, Orsay, France) and Ph. Salin. Nuovo Cimento (10), 27: 309-12 (Jan. 1, 1963). (In English)

Gauge invariant formalism was given for both spin $J = \frac{3}{2}^+$ and $\frac{3}{2}^-$ isobar terms corresponding to π-N resonances. The possible gauge invariant hamiltonians that described the interaction between a nucleon, a π meson, and a $P_{\frac{3}{2}}$ isobar were considered. One interesting feature of the isobaric model was the presence of a small part of electric quadrupole. The effect due to the first $P_{\frac{3}{2}}$ pion-nucleon resonance was described by the hamiltonian and corresponded to a magnetic transition. The small part of the electric amplitude was induced by some relativistic effects due to the covariant form of the hamiltonian. (C.E.S.)

13397 LEPTONS AND LEPTONIC CURRENTS. R. Gatto (Università, Cagliari, Italy and Comitato Nazionale per Energia Nucleare, Frascati, Italy). Nuovo Cimento (10), 27: 313-18(Jan. 1, 1963). (In English)

The group $U_3 = U_1 \times SU_2$ of unitary transformations was applied to μ^+, e^-, and ν, and the particles and currents were classified according to their behavior under U_3 and one of its isotopic spin subgroups. (C.E.S.)

13398 ANALYTIC PROPERTIES OF THE TIME GREEN FUNCTIONS IN THE STATISTICAL MECHANICS OF MANY-BODY SYSTEMS. M. Revzen and L. E. H. Trainor (Univ. of Alberta, Edmonton, Can.). Phys. Letters, 2: 301-3(Nov. 1962). (In English)

Expressions for the Gibbs potential in many-body systems have been derived by Luttinger and Ward using the methods of second quantization and by Klein using the time-dependent statistical Green functions. In this investigation the results of Luttinger and Ward are deduced from those of Klein by making use of the analytic properties of the statistical Green function in the complex time plane. (H.D.R.)

13399 LEPTONIC SPACE WITH AN ADDITIVE MUONIC NUMBER. D. Horn (Israel Inst. of Tech., Haifa). Phys. Letters, 2: 303-4(Nov. 1962). (In English)

A model is developed that predicts an additive muonic number. Conservation laws that stem from an additive muonic number, requiring conservation of charge and leptonic number, are given to show that only those non-

neutrinic reactions that create or annihilate pairs are allowed. Using a rotation through an angle φ as a parameter in a second-kind gauge invariance, a new particle coupled to the muonic charge by the Yang-Mills method is introduced. This new particle will not serve as an intermediate boson of the leptonic interaction, but will be a field similar to the electromagnetic field that will cause attraction between μ^- and e^-. A characteristic Feynman diagram that will account for the e-μ mass difference introduced by the new particle is given. (D.E.B.)

13400 SOME REMARKS ON PERTURBATION CALCULUS. J. Szaniecki (Inst. of Physics, Polish Academy of Sciences, Poznan). Phys. Letters, 2: 308-9(Nov. 1962). (In English)

It is shown from the well-known relations of perturbation calculus that it is possible to obtain perturbation series in a simpler way than a previous formulation by Brueckner. The main difference in method is a change in expressions for the scattering matrix. (H.D.R.)

13401 SCATTERING OF 20 Mev POLARIZED PROTONS BY A TARGET OF POLARIZED PROTONS AND A PRELIMINARY MEASUREMENT OF THE PARAMETER C_{nn}. A. Abragam, M. Borghini, P. Catillon, J. Coustham, P. Roubeau, and J. Thirion (Centre d'Etudes Nucléaires, Saclay, France). Phys. Letters, 2: 310-11(Nov. 1962). (In French)

Protons emerging from a polyethylene target bombarded by 44-Mev alpha particles at an angle of 24° with the incident beam have an energy of 20 Mev and a polarization of 98%. These protons are focused onto a target of 0.2%$-Ce^{3+}$ $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$, which is situated in a magnetic field that can be varied from -13.3 to $+13.3$ kOe. The protons in this target can thus have a polarization of $\pm 20\%$ with respect to the incident-proton polarization. Detectors are set up in the scattering plane at angles of θ and $-\theta\pi/2$ with respect to the incident polarized proton beam. A measurement of the number of coincidences in these detectors, as a function of θ and the target polarization, permits the calculation of the scattering parameter $C_{nn}(\theta)$. The preliminary result $C_{nn}(90° \text{ cms}) = -0.91 \pm 0.05$ is obtained. (T.F.H.)

13402 CALCULATIONS IN THE LADDER APPROXIMATION FOR HIGH ENERGY SCATTERING. J. Cumming and A. W. Hendry (Glasgow Univ.). Phys. Letters, 2: 314-17(Nov. 1962). (In English)

Previous investigators proposed a high-energy scattering model involving ladder diagrams and derived a homogeneous integral equation for the imaginary part of the scattering amplitude in the high-energy limit for neutral scalar meson scattering. Regge trajectories are derived here for the first and second approximations in the iteration process to evaluate the double spectral function obtained in the previous investigations. (H.D.R.)

13403 ANGULAR MOMENTUM WAVE FUNCTION FOR THREE RELATIVISTIC PIONS. R. Raczka (Inst. for Nuclear Research, Warsaw). Phys. Letters, 2: 335-7(Nov. 1962). (In English)

The angular momentum wave function for three relativistic particles is constructed by means of the generalized Clebsch-Gordan coefficients for the Lorentz group. Macfarlane's notation for the free particle state vectors is used, and the wave function is applied to the case of three pions. (H.D.R.)

13404 THE LEE THEORY OF INTERMEDIATE BOSONS AND THE K_{l3} DECAYS. J. S. Bell, Ph. Meyer, and J. Prentki (CERN, Geneva). Phys. Letters, 2: 349-50(Nov. 1962). (In English)

The Lee theory of weak interactions mediated by vector bosons is shown to be in contradiction with present experimental results on the leptonic decays of kaons. Assuming the present data to be correct, a more general class of intermediate boson theories, of which Lee's is a member, is shown to be incorrect. (H.D.R.)

13405 SOME EVIDENCE OF REGGE TRAJECTORY. S. Iwao (Università, Genoa and Istituto di Fisica Nucleaire, Genoa) and G. A. Viano. Phys. Letters, 3: 9-10(Nov. 15, 1962). (In English)

The analytical properties of the angular momenta of the alpha-alpha scattering from resonance states of Be^8 are studied as a typical example of the Regge trajectory in low-energy alpha-alpha scattering. (H.D.R.)

13406 EVIDENCE FOR A T = 2 $\pi\pi$ RESONANCE AT 620 Mev. N. N. Biswas, I. Derado, K. Gottstein, V. P. Kenney, D. Luers, G. Lutjens, and N. Schmitz (Max-Planck-Institut für Physik und Astrophysik, Munich). Phys. Letters, 3: 11-12(Nov. 15, 1962). (In English)

The reactions $\pi^- + p \rightarrow \pi^- + p + \pi^+ + \pi^0$ and $\pi^- + p \rightarrow \pi^- + n + \pi^- + \pi^+ + \pi^+$ at 4 Bev/c were analyzed, and evidence was obtained for a T = 2 π-π resonance at 620 Mev effective mass and full width $\Gamma \approx 75$ Mev. Effective mass distribution curves are shown for various particle combinations from the events. Assuming the T = 2 particle decays strongly, the spin is predicted to be even and the parity and G-parity are both 1^+. (H.D.R.)

13407 THE STIMULATED DECAY OF THE Λ-HYPERON. B. Bhowmik, D. P. Goyal, and N. K. Yamdagni (Univ. of Delhi). Phys. Letters, 3: 13-15(Nov. 15, 1962). (In English)

The relative strengths of proton stimulation (Λ-p) and neutron stimulation (Λ-n) non-mesonic decay interactions of Λ-hypernuclei were investigated by examining 19 observed examples of He-hyperfragments decaying in the non-mesic mode. The (Λ-p) interaction was observed to predominate over the (Λ-n) interaction by a ratio of 3.8 to 1, in excellent agreement with the expected ratio of 4 to 1. (H.D.R.)

13408 UNITARITY OF THE ASYMPTOTIC AMPLITUDE. D. Y. Wong (Univ. of California, San Diego). Phys. Letters, 3: 15-16(Nov. 15, 1962). (In English)

A previous proposal of the existence of a branch cut in the complex angular momentum plane associated with a Regge pole, if one imposes the elastic unitarity condition, is investigated. It is shown that the vacuum pole term itself is consistent with the complete unitarity condition for high energy scattering, provided one also includes the inelastic contribution in the formulation. The unitarity condition is formulated with the aid of the partial wave expansion, and no indication is found for the existence of a cut. (H.D.R.)

13409 A MEASUREMENT OF THE FORWARD CHARGE-EXCHANGE CROSS SECTIONS OF 170 Mev NEGATIVE PIONS IN HYDROGEN. C. Cernigoi (Università, Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy), I. Gabrielli, G. Iernetti, and C. Villi. Phys. Letters, 3: 18-21(Nov. 15, 1962). (In English)

The measurement of the forward charge-exchange cross section $\sigma_0(0^0,\omega)$ for the process $\pi^- + p \rightarrow \pi^0 + n$ was carried out at a π^- energy of 170 ± 3 Mev. The final result is $\sigma_0(0^0 + 8^0) = 5.023 + 0.26$ mb/sterad. The meson-nucleon coupling constant f^2 was determined using all available data on $\sigma_0(0^0,\omega)$ from 95 to 290 Mev and is presented as a χ^2 fit. (H.D.R.)

13410 ESTIMATE OF $\overline{N}N\omega$ COUPLING FROM A REGGE TRAJECTORY. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 3: 21-2(Nov. 15, 1962). (In English)

A previous work has shown that high-energy p-p and $\overline{p}$-p scattering can be reasonably fitted by assuming three dominant Regge trajectories, two with vacuum quantum numbers plus one associated with the ω meson. This empirical fit is extrapolated to give an estimate of the $\overline{N}N\omega$ vector coupling constant. This approach is discussed and compared with other methods. (H.D.R.)

13411 PRODUCTION OF Σ HYPERON-PION PAIRS. Å. Frisk and A. G. Ekspong (Univ. of Stockholm). Phys. Letters, 3: 27-30(Nov. 15, 1962). (In English)

Measurements were made that show clear evidence for a narrow momentum line at 171 ± 2 Mev/c in the Σ-π system produced in K^- capture at rest by light nuclei. The recoil of the residual nucleus was observed to be strongly correlated with the line. The results indicate the existence of a Y^* particle with a mass of 1404.7 ± 0.4 Mev and a width of less than 1.4 Mev. (H.D.R.)

13412 A NOTE ON CASTAGNOLI'S FORMULA. A. A. Kamal and G. K. Rao (Osmania Univ., Hyderabad, India). Phys. Letters, 3: 35-6(Nov. 15, 1962). (In English)

The numerical correction factor n for the recast Castagnoli formula for the energy determination of jets was calculated using experimental values of P_t, the transverse momenta of shower particles. Values of n calculated from the P_t distributions of π mesons obtained in various experiments are compared to n values obtained in other calculations using arbitrary assumptions. (H.D.R.)

13413 ON THE SPINS OF PION-HYPERON RESONANCES. G. F. Wolters (Zeeman Laboratorium, Amsterdam). Phys. Letters, 3: 41-3(Nov. 15, 1962). (In English)

In the determination of the spin of a pion-hyperon resonant state for resonances with mass below the $\overline{K}$-N threshold, sequences of processes like $Y^* \rightarrow Y+$ meson must be considered. It is shown that evidence concerning the value of the resonance-spin can be obtained from the measurement of the polar angle with respect to any z-axis in the Y^* rest-frame, of the direction of motion of the outgoing particles in the disintegration. (H.D.R.)

13414 TWO THEOREMS ON CLASSICAL MANY-PARTICLE SYSTEMS. J. Groeneveld (Universiteit, Amsterdam). Phys. Letters, 3: 50-1(Nov. 15, 1962). (In English)

Two general theorems concerning the partition function and the distribution functions of a classical system of identical particles with additive, central forces are rigorously proved. One concerns the two-particle interaction potential $\phi(i,j)$ $(=\phi(r_i,r_j))$ and the other the coefficients $b_l(V)$ in the Mayer expansion $p(z,V) = \Sigma_l b_l(V) z^l$ and the radius of convergence of this series. (H.D.R.)

13415 PHYSICAL SHEET PROPERTIES OF SECOND TYPE SINGULARITIES. D. B. Fairlie (St. Andrews Univ., Fife, Scotland), P. V. Landshoff, J. Nuttall, and J. C. Polkinghorne. Phys. Letters, 3: 55-6(Nov. 15, 1962). (In English)

A previous work has shown that Feynman amplitudes have certain singularities, called pure second-type singularities, with positions that are independent of the masses of the internal particles. An attempt was made to prove that second type singularities never occur on the physical sheet. The error in this argument is pointed out, and a possible line of attack on the problem is suggested. (H.D.R.)

13416 DIRECT MEASUREMENT OF THE MEAN-LIFE OF THE K_2^0 MESON. J. Darmon, A. Rousset, and J. Six (Ecole Polytechnique, Paris). Phys. Letters, 3: 57-8 (Dec. 1, 1962). (In English)

A study was made of the decays of K_2^0 and K_1^0 produced in the reactions $\pi^- + p \rightarrow \Lambda^0, \Sigma^0 + K^0$ at 1.15 Bev/c incident π^- energy. The events were analyzed by a method independent of any hypothesis on the branching-ratios and not subject to the effect of interference between K_1^0 and K_2^0. The mean-time of flight of the K_2^0 was determined to be $8.7 \pm 0.9 \times 10^{-10}$ seconds and the mean-life to be 5.1×10^{-8} seconds. (H.D.R.)

13417 THE EFFECT OF VELOCITY DEPENDENT FORCES IN NUCLEAR MATTER. [PART] II. A. M. Green (Univ. of California, San Diego, La Jolla). Phys. Letters, 3: 60-1(Dec. 1, 1962). (In English)

In previous work the energy of a system of particles interacting in s-states was calculated using ordinary Born approximation up to second order in the potential. A method is described that shows that with the type of potential used the energy of the many-body system is approximately independent of the strength of the velocity dependent part, provided it fits the same two-body scattering parameters. Also a reasonable approximation to the average energy is given by the series first order term alone. (H.D.R.)

13418 OFF-SHELL PION-PION SCATTERING IN THE T = J = 1 STATE. F. Selleri (Centre d'Études Nucléaires, Saclay, France). Phys. Letters, 3: 76-7(Dec. 1, 1962). (In English)

Any deep study of the π-π interaction is seen to be possible only if an energy and momentum-transfer region can be found where the processes $\pi + N \rightarrow 2\pi + N$ are of peripheral nature. Experimental evidence points to a large OPE contribution to the above process at energies greater than ~1.2 Bev. In order to study secondary effects, regions must be found where the OPE term gives the only contribution. A resonant π-π interaction with a virtual initial pion is used to show how a calculation of the OPE term should be performed in the region $\Delta^2 \leq 10\mu^2$ (Δ is the four momentum of the virtual pion). (H.D.R.)

13419 RESONANCES IN THE Σ-K-π SYSTEM. R. H. March, A. R. Erwin, and W. D. Walker (Univ. of Wisconsin, Madison and Brookhaven National Lab., Upton, N. Y.). Phys. Letters, 3: 99-101(Dec. 1, 1962). (In English)

A total of 266 cases of Σ-K-π states produced by 2.1 Bev/c π^- was observed in a hydrogen bubble chamber. The distribution of these events by charge states is given, and the cross sections are compared to previous results at 1.9 Bev/c. The observed effective mass distributions are shown and the Σ-K-π resonances are discussed. (H.D.R.)

13420 POSSIBLE TESTS OF THE ELEMENTARITY OF THE PHOTON AND THE ELECTRON. A. P. Contogouris (Nuclear research center, Demokritos, and Center for Advanced Study in Physics, Agia Paraskevi, Athens). Phys. Letters, 3: 103-5(Dec. 1, 1962). (In English)

A test of the elementarity of the photon is suggested by means of the electron-electron colliding beam experiment. Since the process $e^- + e^- \rightarrow e^- + e^-$ cross section to the order α^3 has been calculated in detail, any significant deviation of the experimental cross section may be attributed to the non-elementary character of the proton that is exchanged. The process $e^+ + e^- \rightarrow \gamma + \gamma$ is also analyzed as a possible test of the elementarity of the electron, for, if the photon is a Regge particle, there is no reason to dismiss the same possibility for the electron. (H.D.R.)

13421 ON THE FOUR-COMPONENT NEUTRINO THEORY. A. A. Sokolov (Moscow State Univ.). Phys. Letters, 3: 211-12(Jan. 15, 1963). (In English)

The four-component Dirac equation with zero rest mass may be used to describe neutrino helicity. This gives four different states. Two independent solutions possessing different helicity may be obtained. In the four component theory, the introduction of a definite helicity of the neutrino as well as the use of complex coupling constants does not destroy weak time inversion and space inversion invariance. (C.E.S.)

13422 TEST OF THE CONSERVED VECTOR CURRENT HYPOTHESIS IN $\Sigma^+ \rightarrow \Lambda^0$ LEPTONIC DECAYS. N. Cabibbo and P. Franzini (CERN, Geneva). Phys. Letters, 3: 217-20(Jan. 15, 1963). (In English)

A test of the conserved vector current hypothesis can be performed through the combined branching ratio for the decays $\Sigma^+ \rightarrow \Lambda^0$, the average Λ^0 polarization from unpolarized Σ, and the Λ^0 hyperon spectrum. (C.E.S.)

13423 COUPLING OF THE POMERANCHUK PARTICLE TO THE PION AND ITS DECAY WIDTH. F. T. Hadjioannou and A. H. Zimerman (CERN, Geneva). Phys. Letters, 3: 220-1(Jan. 15, 1963). (In English)

The constant for Pomeranchuk particle coupling to two π mesons was estimated using the high-energy cross sections in the Regge pole approach. The high-energy π-π total cross section was determined from the high-energy π-N and N-N total cross sections using the factorization theorem. In the Regge pole approach the high-energy amplitude for π-π elastic scattering was dominated by the Regge pole of the Pomeranchuk particle. (C.E.S.)

13424 PLASMON SATELLITES OF SOFT X-RAY EMISSION SPECTRA. G. A. Rooke (Univ. of Western Australia, Nedlands). Phys. Letters, 3: 234-6(Jan. 15, 1963). (In English)

Spectra were recorded from aluminum, magnesium, and sodium and added in a pulse analyzer. The spectra were plotted on a large scale and a smooth interpolated background drawn. The difference between the spectrum and background together with the parent spectrum shifted to a lower energy by the amount of the observed plasmon energy. A search was made for a high energy satellite but none were observed. (C.E.S.)

13425 PROTON–PROTON SCATTERING AT 24 Bev/c. E. Cieslak and E. Marquit (Univ. of Warsaw). Phys. Letters, 3: 237-8(Jan. 15, 1963). (In English)

Elastic scattering of 24-Bev/c protons on free protons in emulsion were studied by means of the normal incidence technique. A stack of thirty 5×10 cm^2 Ilford G5 emulsion pellicles were exposed perpendicularly to the protons. The average beam intensity was $(3.76 \pm 0.08) \times 10^5$ protons/cm^2. The hydrogen concentration was $(3.18 \pm 0.06) \times 10^{22}$ atoms/cm^2. (C.E.S.)

13426 REINTERPRETATION OF THE Z EVENTS. M. Roos (Nordisk Institut for Teoretisk Atomfysik, Copenhagen). Phys. Letters, 3: 242-3(Jan. 15, 1963). (In English)

It was pointed out that the evidence for ζ may very well be reinterpreted as evidence for two distinct π-π resonances, the ζ at about 565 Mev and a new resonance δ at about 625 Mev. The isospin seems to be T = 1 for ζ and T = 2 for δ. (C.E.S.)

13427 SPIN CORRELATION EXPERIMENTS IN PROTON–PROTON SCATTERING AT 380 Mev. J. V. Allaby, A. Chisholm, J. Eades, and A. N. James (Univ. of Liverpool). Phys. Letters, 3: 253-4(Jan. 15, 1963). (In English)

Experiments measuring the spin-correlation parameters for proton-proton scattering at a c-m angle of 45° were performed. The 380-Mev proton beam from the Liverpool synchrocyclotron was scattered from a liquid hydrogen target, and the spin-correlation parameters were determined by rescattering the two emergent protons simultaneously. (C.E.S.)

13428 VARIATION IN POSITRON LIFETIME WITH PRESSURE. R. K. Wilson, P. O. Johnson, and R. Stump (Univ. of Kansas, Lawrence). Phys. Rev., 129: 2091-5 (Mar. 1, 1963).

The mean life of the long-lived component of positrons annihilating in various solids and liquids has been measured at pressures up to 6000 atm and temperatures up to 200°C. At fixed temperature, the mean life decreases exponentially with the change in volume due to increasing pressure. At fixed volume, the lifetime decreases with increasing temperature. A qualitative explanation of the variation is presented. (auth)

13429 HIGH-FREQUENCY LIMIT OF 15.1-Mev BREMSSTRAHLUNG. H. E. Hall, A. O. Hanson, and D. Jamnik (Univ. of Illinois, Urbana). Phys. Rev., 129: 2207-17(Mar. 1, 1963).

The 15.1-Mev scattering resonance in carbon is used to study the yield of photons at the high-frequency limit of the bremsstrahlung spectrum. A survey of the yield at 0° was carried out for several elements. The 0° yield at the limit increases strongly with the atomic number in agreement with recent calculations. Measurements of the 15.1-Mev isochromats from a thin thorium (Z = 90) target for several angles are presented and compared with available calculations. A value of 1.61 ± 0.16 mb is obtained for $(k/Z^2)\,(d\sigma/dk)$, the cross section integrated over angle. This is in reasonable agreement with theoretical values of 1.96 mb based on the inverse photoeffect and 1.74 mb as obtained from a direct evaluation of the bremsstrahlung matrix element in the extreme relativistic limit. (auth)

13430 POLARIZATION OF THE PROTON FROM THE $\gamma + n \rightarrow p + \pi^-$ REACTION. J. R. Kenemuth and P. C. Stein (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 129: 2259-64(Mar. 1, 1963).

The polarization of the proton from the $\gamma + n \rightarrow p + \pi^-$ reaction in deuterium has been experimentally measured at 90° in the center-of-mass system for photon energies near 715 Mev by using a counter technique to observe the left to right asymmetry in the scattering of the protons from carbon. A value of -0.26 ± 0.06 was observed, with the direction of the polarization defined by $\hat{n} = (\hat{k} \times \hat{q})/|\hat{k} \times \hat{q}|$, where $\hat{k}$ and $\hat{q}$ are, respectively, unit vectors in the directions of the photon momentum and the pion momentum. The result is interpreted as an indication that the interference between the $P_{\frac{3}{2}}$ (325 Mev) and $D_{\frac{3}{2}}$ (750 Mev) resonances may not be the dominant contribution to the polarization at this energy. Significant contributions from either an interference between the $P_{\frac{3}{2}}$ (325 Mev) resonance and the possible new resonance suggested by the π, p scattering measurements, or an interference between the $D_{\frac{3}{2}}$ (750 Mev) and $F_{\frac{5}{2}}$ (1050 Mev) resonances, or a combination of these two possibilities seem to be required. (auth)

13431 LOW-ENERGY PHOTOPRODUCTION OF Λ^0 AND K^+ FROM PROTONS. T. K. Kuo (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 129; 2264-74(Mar. 1, 1963).

A model is constructed for low-energy $\gamma + p \rightarrow K^+ + \Lambda^0$ reactions in accordance with dispersion theory by neglect-

ing faraway singularities. Thus, besides the Born terms due to one-nucleon intermediate state and K^+ exchange, we also employ the K^* exchange and a resonance in the final state similar to that found in the reaction $\pi^- + p \rightarrow K^0 + \Lambda^0$. A fairly good fit with recently measured data is obtained. [See R. L. Anderson et al., Phys. Rev. Letters, 9: 131 (1962)]. The choice of parameters is briefly discussed. (auth)

13432 METHODS FOR TESTING THE CPT THEOREM. R. G. Sachs (Univ. of Wisconsin, Madison). Phys. Rev., 129: 2280-5(Mar. 1, 1963). (TID-16927)

The decay and interactions of the neutral K mesons are shown to provide some direct tests of the validity of the CPT theorem for weak interactions of strange particles. The connection with related tests of CP and T invariance is also discussed. It is found that the absence of a 2π decay mode of the K_2 is an indication of CP invariance of the nonleptonic interactions of the K meson but not a proof thereof. Even if CPT invariance is assumed, the 2π mode does not provide an unambiguous test of CP invariance. It is shown that the absence of a detectable charge asymmetry in the leptonic decay of the K_2 indicates either CPT or CP invariance of the leptonic interactions if the nonleptonic interactions are assumed to be CP invariant. A direct test of CP invariance would be provided by a measurement of the interference term in the leptonic decay curve of the K^0, as noted by Sachs and Treiman. A direct test of CPT invariance would be provided by an accurate measurement of the interference term for each of the charge states in the leptonic decay of the K^0. It is shown that a specific test of combined CPT and CP invariance of the weak interactions would be provided by a measurement of the elastic and regenerative scattering of K_1 and K_2 mesons by nuclei. The value of the $K_1 - K_2$ mass difference determined by the interference method is found to be independent of the question of CPT or CP invariance. On the other hand the evidence for $\Delta S = -\Delta Q$ transitions obtained from the ratio of the leptonic decay rates of K_1 and K_2 mesons does depend on the assumption of either CPT or CP invariance of the nonleptonic interactions. This ambiguity can be removed by an accurate determination of the charge asymmetry in the leptonic decays. (auth)

13433 K^+-p AND K^--p TOTAL CROSS SECTIONS IN THE MOMENTUM RANGE 3-19 Bev/c. W. F. Baker, R. L. Cool, E. W. Jenkins, T. F. Kycia, R. H. Phillips, and A. L. Reed (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2285-91(Mar. 1, 1963). (BNL-6492)

The total cross sections of K^+ and K^- mesons on protons have been measured between 3 and 19 Bev/c at the Brookhaven alternating gradient synchrotron. The data were obtained from measurements of attenuation in a liquid hydrogen target. The K mesons were defined in momentum by magnetic deflection and a scintillation counter telescope. They were identified by measuring the velocity with a high-pressure gas-filled Cherenkov counter. Values of the cross sections were obtained at intervals of ~1 Bev/c with an error for each value of approximately 5%. $\sigma_t(K^+p)$ is, within errors, constant over the entire momentum range with a value of 18.4 mb. $\sigma_t(K^-p)$ decreases gradually from a value of 28 mb at 4 Bev/c to 21.6 mb at 19 Bev/c. The cross sections are significantly different up to the highest momenta reached in this experiment. (auth)

13434 SURFACE CORRECTIONS TO THE HIGH-ENERGY OPTICAL POTENTIAL. R. E. Schenter and B. W. Downs (Univ. of Colorado, Boulder). Phys. Rev., 129: 2292-7(Mar. 1, 1963).

The dependence of the nucleon-nucleon scattering matrix on the momentum transfer q is taken into account in a derivation of the high-energy (local) optical potential. This leads to an optical potential characterized by radial functions which have larger mean radii and more diffuse surfaces than does the nucleon distribution in the target nucleus, to which these functions reduce when the q dependence is neglected. (auth)

13435 EXPERIMENTAL CONSEQUENCES OF THE MAJORANA THEORY FOR THE MUON'S NEUTRINO. Richard Friedberg (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 129: 2298-2300(Mar. 1, 1963).

The Majorana theory applied to the muon's neutrino predicts lepton-nonconserving phenomena with a small probability of second order in m_ν, the neutrino mass, and a, the deviation from V−A theory. In particular, in the coupled reactions $\pi \rightarrow \mu + \nu_\mu$, $\nu_\mu + Z \rightarrow Z' + \mu$, where Z and Z′ are nuclei, there is a small probability that the muon produced in the second reaction has the same sign as the original π. This probability is computed to lowest order in a and m_ν. It may be as great as 8/100, consistent with present experimental upper limits on a and m_ν. If we assume a = 0, the probability goes as m_ν^2 and cannot be more than 1/200. If a small lepton-nonconserving effect were to be observed, the problem might arise of distinguishing between nonvanishing a and nonvanishing m_ν. This might be done by an improved measurement of the high-energy part of the electron spectrum in μ decay. To this end the electron spectrum is calculated exactly as a function of energy, angle, m_ν, and a. It is seen that m_ν has an enhanced influence on the high-energy part, whereas the influence of a is of the same order of magnitude at all energies. (auth)

13436 π^--p ELASTIC SCATTERING AT 310 Mev: DIFFERENTIAL CROSS-SECTION AND RECOIL-PROTON POLARIZATION. Hugo R. Rugge and Olav T. Vik (Univ. of California, Berkeley). Phys. Rev., 129: 2300-10(Mar. 1, 1963). (UCRL-10420)

The differential cross section and recoil proton polarization in π^--p elastic scattering at 310-Mev incident-pion energy has been measured. The differential cross section was measured at 28 angles in the angular region $25 \leq \theta_{lab} \leq 160$ deg. The fractional rms errors were typically 3%. The reaction was observed by counting the scattered pions emerging from a liquid-hydrogen target with a counter telescope consisting of scintillation and Cherenkov counters. Simultaneously, the recoil-proton polarization was measured at four angles in the angular region $114 < \theta_{c.m.} < 146$ deg. The recoil protons from the liquid-hydrogen target were scattered from a carbon target and the left-right asymmetry was measured. Scintillation counters were used throughout to detect the particles. (auth)

13437 PION-NUCLEON ELASTIC SCATTERING AT 310 Mev: PHASE-SHIFT ANALYSIS. Olav T. Vik and Hugo R. Rugge (Univ. of California, Berkeley). Phys. Rev., 129: 2311-22(Mar. 1, 1963). (UCRL-10436)

A phase-shift analysis of π^+-p and π^--p elastic scattering at 310 Mev has been performed. The data include differential and total cross-section and recoil-proton polarization data for both π^+-p and π^--p elastic scattering, as well as differential cross-section data for charge-exchange scattering. Inclusion of d waves was necessary to attain an adequate fit to the data; in the case of π^--p differential cross section, the best fit included f waves. A general phase-shift search using s, p, and d waves was carried out; a single solution was obtained that adequately fit all the available data. The most notable characteristics of this solution are isotopic-spin $\frac{3}{2}$ phase shifts similar to those

obtained in a previous analysis of the π^+-p data and a relatively large $D_{1,5}$ phase shift equal to approximately 15 deg. Errors on the isotopic-spin $\frac{1}{2}$ phase shifts of this solution range from 0.3 to 0.9 deg. The isotopic-spin $\frac{3}{2}$ phase-shift errors are similar to those obtained previously. Because the π^--p differential cross section data indicated a possible need for f waves, and since the only satisfactory spd solution displayed a large d-wave phase shift in the isotopic-spin $\frac{1}{2}$ state, the analysis was extended to include f waves. The result of allowing f waves was to increase the errors on each of the phase shifts (up to about 2 deg), and also to introduce two new solutions, neither of which can be ruled out statistically. These new solutions are similar to the d-wave solution in the isotopic-spin $\frac{3}{2}$ phase shifts, but vary rather widely in isotopic-spin $\frac{1}{2}$ phase shifts. Inelastic scattering processes were neglected throughout most of the analysis; however, a study of their effects on the final solutions was made and these effects were seen to be unimportant. (auth)

13438 THEORY OF THE PROCESS $p + p \rightarrow d + W^+$. Jeremy Bernstein (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2323-5(Mar. 1, 1963). (BNL-6449)

A simple theory for the process $p + p \rightarrow W + d$ is developed. Detailed numerical results are obtained by choosing particular wave functions. A discussion of the expected corrections to the calculation is also given. (auth)

13439 SEARCH FOR THE DIRAC MONOPOLE WITH 30-Bev PROTONS. Edward M. Purcell (Harvard Univ., Cambridge, Mass.), George B. Collins, Tadao Fujii, John Hornbostel, and Frank Turkot. Phys. Rev., 129: 2326-36 (Mar. 1, 1963). (BNL-6506)

A search was made at the Brookhaven alternating gradient synchrotron for magnetic monopoles produced either in collisions of 30-Bev protons with light nuclei, or produced by γ rays secondary to these protons in the Coulomb field of protons or of carbon nuclei. In runs using 5.7×10^{15} circulating protons, no monopole-like event was found. This implies an upper limit for production in proton-nucleon interactions of about 2×10^{-40} cm^2. Experimental limits are also derived for the photoproduction of pole pairs. (auth)

13440 PROPERTIES AND EFFECTS OF η DECAYS. Riazuddin (Panjab Univ., Lahore, Pakistan) and Fayyazuddin. Phys. Rev., 129: 2337-41(Mar. 1, 1963).

The partial widths for the $\pi^+\pi^-\pi^0$ and $3\pi^0$ decay modes of the η meson are calculated via an effective electromagnetic vertex $\eta^0 \rightarrow \pi^0$, the strength of which is estimated from the electromagnetic violation of the charge independence of nuclear forces. A picture consistent with experiment is obtained. The effect of η on violation of the $\Delta T = \frac{1}{2}$ rule for the nonleptonic decays of K mesons is also considered, and in particular it is shown that the observed ratio for $K^+ \rightarrow 2\pi$ versus $K_1^0 \rightarrow 2\pi$ can be explained by this picture. Lastly, by comparing total decays of $K_2^0 \rightarrow \pi^+\pi^-\pi^0$ and $\Sigma^- \rightarrow n + \pi^-$ via the K–π weak vertex, the coupling constant $g\Sigma NK^2$ is estimated. (auth)

13441 NONLINEAR INTERACTION OF LIGHT IN A VACUUM. J. McKenna and P. M. Platzman (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 129: 2354-60(Mar. 1, 1963).

Semiclassical methods are used to study the nonlinear interaction of light in vacuum. The study was motivated by a desire to investigate the possibility of using recently developed light sources (lasers) to demonstrate the existence of these minute nonlinear effects. As is well known, Maxwell's equations can be modified by the addition of certain nonlinear terms so that they correctly describe the interaction of low-energy photons. Using these equations, an expression is derived for the counting rate for photons produced by two photons colliding inelastically in the presence of an external, static electric field. A derivation along these lines is also given for the well-known scattering cross section in the case of two photons colliding elastically to give two photons. (auth)

13442 EVIDENCE FOR K* SPIN ALIGNMENT AND POSSIBLE EXCHANGE MECHANISM IN THE REACTION $\pi^-p \rightarrow \sigma^0K^*$. Gerald A. Smith, Joseph Schwartz, Donald H. Miller, George R. Kalbfleisch, Robert W. Huff, Orin I. Dahl, and Gideon Alexander (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 138-41(Feb. 15, 1963). (UCRL-10573)

Angular distributions from exposure of a liquid-hydrogen bubble chamber to a π^- beam are measured in a study of the spin assignment for K* in the reaction $\pi^- + p \rightarrow \Sigma^0 + K^*$. An exchange mechanism model is shown to produce a good fit to the data when the K* spin is taken as 1^-.

13443 SOLUTIONS TO DISPERSION EQUATIONS FOR NUCLEON-NUCLEON SCATTERING. A. Scotti and D. Y. Wong (Univ. of California, San Diego). Phys. Rev. Letters, 10: 142-6(Feb. 15, 1963).

Dispersion relations are used to calculate elastic nucleon-nucleon scattering phase shifts from zero to 400 Mev, including the exchange of the multipion resonances ρ, ω, and η. Exchange of an S-wave pion-pion pair in the form of an effective scalar particle is included in addition to the resonance exchange and single-pion exchange. Pole terms are calculated using renormalized Born approximation, and solution for partial-wave amplitudes follows. Phase shift analysis is compared with those of the Livermore and Yale groups. The exchange mechanism aided by relativistic dispersion relations is seen to give a coherent description of nucleon-nucleon scattering. (D.C.W.)

13444 X-RAY SCATTERING ON CRYSTALS WITH DISLOCATION. II. CONSIDERATION OF THE NONLINEAR DISPLACEMENT FIELD OF A SCREW DISLOCATION. M. Wilkens (Max-Planck-Institut für Metallforschung, Stuttgart). Phys. Status Solidi, 2: 1508-23 (1962). (In German)

The intensity of scattered x rays is investigated as a function of the coordinates in the reciprocal lattice. The investigation is made for a cylindrical crystal containing an axial screw dislocation and is based on the displacement field obtained from the nonlinear isotropic theory of elasticity. Expressions are derived for the displacements of intensity in the "central parts" of the reflections. In the "central parts" the intensity of the reflections attains high values. The use of Debye-Scherrer coordinates in these expressions gives effective changes of the lattice constants. These changes depend essentially on the indexing of the Debye-Scherrer-line. They are in general much smaller than the values which correspond to the mean differential lattice expansion. (auth)

13445 ENERGY MOMENTS OF SCATTERING PHASE SHIFTS. I. C. Percival (Queen Mary Coll., London). Proc. Phys. Soc. (London), 80: 1290-1300(Dec. 1962).

By generalizing the relation $\mathrm{Tr}H^p = \Sigma_\gamma E_\gamma^p$ between a Hermitian matrix H and its eigenvalues E_γ, moment relations are obtained for the energy spectrum of a nonrelativistic particle undergoing elastic s-wave scattering by a spherically symmetric potential V(r). The energy moments of the phase shift δ and $d\delta/dE$ are obtained in terms of the potential V(r) and its radial derivatives.

$|V(r)|$ must be integrable, and V(r) non-singular and differentiable any number of times; its odd derivatives must vanish at the origin. The high-energy divergence of the energy moments is removed by means of an asymptotic expansion. The moment relations for s-wave scattering are given. The results of Dikii on the Sturm-Liouville problem are thus extended to systems with a continuous or mixed spectrum. (auth)

13446 THE LORENTZ COVARIANT LEE MODEL. J. L. Martin (National Physical Lab., Teddington, Middlesex, Eng.). Proc. Roy. Soc. (London), Ser. A, 271: 332-56 (Jan. 22, 1963).

A quantum theory of interacting particles with rigorous Lorentz covariance and rigorous conservation laws of Lee type is set up; the process $A \rightarrow B_1 + B_2$ is permitted via a point interaction. For simplicity the particles are assumed to be scalars. The complete solution of the lowest "sector" of interest is straightforward in configuration space for the case of one space dimension. It is in the case of three space dimensions that the usual difficulties associated with a point interaction arise; it is shown that the use of a cut-off is not a reliable procedure in this context, and a section of the paper is devoted to the development of a device for dealing with these difficulties that differs from the usual renormalization method. It is found that applying this device to the covariant model leads to a theory that is without infinite renormalization of any kind, and that admits a legitimate "physical" interpretation after certain necessary "supplementary conditions" are applied. The S-states in the lowest sector are fully described in configuration space. Finally, an indication of the variety of different models that may be obtained is given, and it is found that certain models that are at first sight unacceptable on account of their structure in the absence of interaction lead in fact to "physical" consequences that are perfectly satisfactory. (auth)

13447 QUANTUM STATISTICAL MECHANICS OF A MANY-BODY SYSTEM OF INTERACTING PARTICLES. R. K. Pathria and M. P. Kawatra (Univ. of Delhi). Progr. Theoret. Phys. (Kyoto), 27: 1085-1102(June 1962). (In English)

The binary collision method is applied to a study of the equilibrium properties of a many-body system of particles interacting through a generalized two-body potential. It is found that to order α^2/λ^2, where α and λ represent respectively the range of the two-body interaction and the mean thermal wavelength of the particles, the final results can be written down explicitly in terms of the relevant phase shift for the S-waves. Ground-state properties of a few systems of particles interacting through certain typical potentials and obeying Fermi-Dirac or Bose-Einstein statistics are studied. (auth)

13448 RESEARCH OF p-p SCATTERING AT 10 Mev BY THE DISPERSION RELATION. Shih-Hui Hsieh (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1103-27(June 1962). (In English)

Nucleon-nucleon scattering is studied by the dispersion relation as a function of momentum transfer. The spectra functions arising from the two-pion contribution are calculated. The theory is applied to p-p scattering at 10 Mev. It is shown that such a dispersion relation may be correct, but a definite conclusion as to its correctness cannot be reached. It is indicated that in such a dispersion relation the two-pion contribution (and possibly higher pion contributions) appear from lower energies. The two-pion effect is quite large at 10 Mev. (auth)

13449 QUALITATIVE ARGUMENTS CONCERNING THE BOSE-EINSTEIN CONDENSATION OF FERMION PAIRS. John M. Blatt (Univ. of New South Wales, Kensington, Australia). Progr. Theoret. Phys. (Kyoto), 27: 1137-42(June 1962). (In English)

A detailed calculation shows that the Fermi-Dirac statistics of the particles making up a "pair" or "molecule" does not interfere with, but rather aids, Bose-Einstein condensation of these pairs. Simple qualitative arguments are presented that may be useful in understanding this result. (auth)

13450 A MODEL OF THREE-PION RESONANCE IN TERMS OF THE STRONG P-WAVE TWO-PION RESONANCE. Ken Kawarabayashi and Akira Sato (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1143-55(June 1962). (In English)

A model of a three-pion resonance, in which two resonating pions in a P-state relative to each other are represented by an unstable vector meson field (ρ meson), is considered. An integral equation for the ρ meson-pion system is constructed, which shows that the strongest attractive force results in the T = 0, J = 1 and odd parity state. The width of the three-pion resonance is also discussed in terms of the width of the ρ meson within the limit of the chain approximation. (auth)

13451 A DERIVATION OF THE PROBABILITY DENSITY FOR THE BETHE-SALPETER EQUATION. J. Reinfelds (Univ. of Adelaide). Progr. Theoret. Phys. (Kyoto), 27: 1165-87(June 1962). (In English)

A solution of the Bethe-Salpeter equation is derived by a simple and direct method. The instantaneous interaction and ladder approximations are used. A function of the Bethe-Salpeter amplitude is found to satisfy a continuity equation. This function reduces to $\psi^* \psi$ for free particles, and it is therefore interpreted as the particle probability density for interacting particles. Non-relativistic interaction energies are assumed to simplify the equations and to make numerical computations possible. This assumption leads to Schrödinger equations, with a singularity in the potential that defines the core radius of the nuclear force. The deuteron binding energy is used to determine the core radius of the nuclear force, which is the only adjustable parameter of the theory. This core radius is used to calculate the quadrupole moment of deuteron. Qualitative agreement with experiment is obtained. (auth)

13452 FINAL STATE INTERACTION IN KAON PRODUCTION. Justin Huang and Julius Kovacs (Michigan State Univ., East Lansing). Progr. Theoret. Phys. (Kyoto), 27: 1188-92(June 1962). (In English)

The final state approach is applied to the reaction $\pi^- + P \rightarrow K + Y + \pi$. The π-Y and K-Y interactions are neglected and only the K-π interaction is considered in the final state. The matrix elements for the primary interaction are determined by the use of Fermi's statistical model. The secondary interaction is handled by the use of effective range formulae, where the parameters are fitted to the experimental full width at half maximum of 23 Mev and an effective mass of 878 Mev for an $I = \frac{1}{2}$ resonance. Both an S-wave and P-wave resonance are considered. The results indicate a $K^0\pi^+\Sigma^-/K^+\pi^0\Sigma^-$ ratio of 1.7 with a small amount of $K^0\pi^-\Sigma^+$ reaction for both the S- and P-wave cases. This result is in agreement with experimental results. The calculations also indicate a $K^+\pi^0\Sigma^-/K^0\pi^0\Sigma^0$ ratio of 1.7 for an S-wave resonance and a ratio of 0.7 for a P-wave resonance. (auth)

13453 DISPERSION RELATIONS FOR THE ELASTIC SCATTERING AMPLITUDE WITH THE ANOMALOUS IMAGINARY PART. Jun Otokozawa (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), 27: 1193-8(June 1962). (In English)

Using the anomalous imaginary part of the elastic scattering amplitude, the single-dispersion representation of the π-meson–deuteron scattering amplitude is made. The contribution of the anomalous imaginary part to the total integral is estimated and shown to be small. (auth)

13454 ON THE FULL SYMMETRY IN SAKATA MODEL. Yasuo Hara, Yorikiyo Nagashima, and Ghanshyam P. Singh (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1221-32 (June 1962). (In English)

Some kinematical consequences of the full symmetry in the Sakata model on the scattering of mesons by baryons (p, n, and Λ), on baryon-(anti)baryon scattering, and on meson-meson scattering are derived. Some of the relations are compared with experiment. The agreement is not satisfactory at low energies because of the mass differences among nucleons and the Λ particle. Some of the disagreements may be explained if the renormalization effect is taken into account. Starting from the coupling-constant ratio $g^{\omega}_{KN\Lambda}/g^{\omega}_{\pi NN} = 2$, which must be satisfied if the full symmetry holds for particles without soft clouds, the ratio $g^2_{KN\Lambda}/g^2_{\pi NN}$ is found to be consistent with the value $1/10$, using the static theory. Relations among total cross sections in Gell-Mann's scheme are also derived. (auth)

13455 PHENOMENOLOGICAL MODEL FOR π^--P ELASTIC SCATTERING NEAR RESONANCES. Tetsurô Sakuma and Tetsuya Tsuchida (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 27: 1272-4(June 1962). (In English)

A study is made to determine whether the observed forward diffraction peak and the backward bump in the π^--p elastic scattering cross sections, at energies on the order of 1 Bev, can be explained in terms of the second and third π-nucleon resonances and the $T = J = 1$ π-π resonance. It is concluded that a weak coupling is required, in order to produce a reasonable cross-section magnitude; that the model proposed reproduces the backward bump; that nonresonant amplitudes must be taken into account in the diffraction peak; and that the polarization of the recoil proton should be about 50%. (T.F.H.)

13456 RADIATIVE DECAY OF THE η-PARTICLE. Akihiko Fujii (CNRN, Frascati, Italy). Progr. Theoret. Phys. (Kyoto), 27: 1274-5(June 1962). (In English)

The branching ratio (w_1/w_2) for $(\eta^0 \rightarrow \pi^0 + \gamma/\eta^0 \rightarrow \pi^+ + \pi^- + \pi^0)$ is estimated. The calculation used employs the general matrix element for the decay of a vector particle. The result is $w_1/w_2 = 0.39\beta^3$, where β is a phenomenological parameter that includes the unknown form factors. (T.F.H.)

13457 ON THE SPIN OF η MESON. Shigeo Minami (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1275-6(June 1962). (In English)

Under the assumption that the η meson is pseudoscalar, the properties of the reactions $\pi^+ + d \rightarrow p + p + \eta^0$ and $p + p \rightarrow p + p + \eta^0$ are examined near threshold. It is concluded that if the experimental data for the first (second) reaction show strong s-wave (p-wave) interactions, and if the reactions have large cross sections, the η meson is more likely vector than pseudoscalar, and vice versa. (T.F.H.)

13458 K^--p INTERACTION AT 760 Mev/c AND A POSSIBLE RESONANT STATE. Shigeo Minami (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 27: 1285-7(June 1962). (In English)

The existence of a resonant state in the near-threshold reaction $K^- + p \rightarrow \Lambda + \eta$ is suggested, in order to account for the observation that the reaction cross section at 760 Mev/c (quite near the threshold) is ≤ 0.1 times the cross section at 850 Mev/c. (T.F.H.)

13459 ON THE EXISTENCE OF A BOSON μ^0. Mituo Taketani and Makoto Sawamura (Universidade, São Paulo, Brazil). Progr. Theoret. Phys. (Kyoto), 27: 1287-9(June 1962). (In English)

It is shown that the existence of a μ^0 Bose meson is not inconsistent with experimental data. Possible decay modes of this meson are conjectured. (T.F.H.)

13460 ELECTRON AS A FUNDAMENTAL ELEMENTARY PARTICLE. [PART] I. Usaku Kakinuma. Sci. Papers Inst. Phys. Chem. Res. (Tokyo), 56: 235-43(Dec. 1962).

Elementary particles may be nothing but an electron existing under a certain condition, or a group of electrons that are formed to a certain combined state. Therefore, the knowledge of the electron structure is the starting point of our investigation about matter. To obtain the structure, the electron in an absolutely statical state is considered first and is studied by use of the gage-transformation defined in a modified way. This leads to the discovery of a revised expression for the electromagnetic energy-tensor inside the electron as well as the wave equation for the electron formally similar to the Schrödinger equation for the hydrogen atom. However, our wave equation is interpreted as indicating the mode of energy distribution in the electron. To linearize the wave equation, a complex Riemannian geometry has been developed with results promising to be serviceable for further studies. (auth)

13461 POLARIZATION OF FAST DEUTERONS IN THE SCATTERING ON PROTONS AND NUCLEON-NUCLEON INTERACTIONS. S. G. Matinyan and O. D. Cheishvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 95-102(1962). (In Russian)

To avoid a non-unique phase analysis of nucleon-nucleon scattering at high energy, it is proposed to study polarization of deuterons in their elastic scattering on protons. The expression for polarization tensors of a deuteron beam is given in terms of the phases of N-N scattering. The whole consideration is carried out phenomenologically. It was found that the study of polarization of deuterons differs considerably from the sets of phases of Marshak and Signell on the one hand and of Gammel and Thaler on the other. At high energy the vector polarization of deuterons seems to be important. (auth)

13462 CHARGED Σ-HYPERONS LIFE TIME. Z. Sh. Mandzhavidze, N. N. Roinishvili, D. V. Gersamia, A. A. Kozlov, D. M. Kotliarevski, T. D. Purtseladze, N. G. Tatalashvile, and L. Z. Shtemanetian. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 125-9(1962). (In Russian)

The lifetime of charged Σ hyperons registered by magnetic cloud chamber at 1800m above sea level was studied. The technique and method are different from those usually used for measuring the lifetime of Σ hyperons. It is shown that lifetimes of Σ^+ and Σ^- hyperons agree well with other data. No short-lived component with a lifetime less than 10^{-10} sec was found. (auth)

13463 ANALYTICAL PROPERTIES OF THE SCATTERING AMPLITUDE AND LIFE TIME OF Σ^0-HYPERONS. L. V. Laperashvili and S. G. Matinyan. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 161-72(1962). (In Russian)

An analytical continuation of the amplitude of the transition of the processes $\gamma + p \rightarrow K^+ + \Lambda^0$ and $\gamma + p \rightarrow K^+ + \Sigma^0$

to the pole corresponding to Feynman's diagram, with a Σ^0 or Λ^0 hyperon in the intermediate state respectively, is made by the extrapolation procedure of Chew and Low. The differential cross section of the above mentioned processes in the pole is associated with the lifetime of a Σ^0 hyperon with respect to the decay $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. (auth)

13464 PART I. TRIDENT PRODUCTION AND QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES. PART II. THE EFFECT OF THE π-K INTERACTION ON THE ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. Mao chao Chen. Thesis, Stanford Calif., Stanford Univ., 1962. 94p.

I. The cross section was calculated for the coincidence experiment of electron-positron pair production from electron-proton collision as a test of quantum electrodynamics at small distances. The electrons and positrons are considered highly relativistic and the protons are considered as Coulomb field sources; otherwise the calculations are exact to the fourth order of matrix element. Distances probed are about 0.5f. II. π-K coupled solutions are applied to evaluate the relative contributions of 2K and 2π intermediate states to the isovector part of the nucleon's electromagnetic form factor. Spin and unphysical branch cut on the left are neglected. It is assumed that the K and nucleon N are coupled indirectly through the K-π and π-N couplings only. Approximate integrations are carried out for different limiting cases. Except in the case when π-π self-coupling and π-K coupling are both weak and the results do not show a definite trend, all other cases show that the 2K-state contribution to the nucleon vector form factor is small. Maximum cross sections and resonance energies for the process $\pi\pi \rightarrow \pi\pi$ and $\pi\pi \rightarrow K\overline{K}$ were also evaluated. (Dissertation Abstr., 23: No. 6, Dec. 1962)

13465 AN EXPERIMENTAL TEST OF THE LAW OF CONSERVATION OF NUCLEONS. Charles Carl Giamati, Jr. Thesis, Cleveland, Cast Inst. of Tech., 1962. 80p.

An improved measurement of the lower limits of the lifetime of nucleons against spontaneous decay by processes which do not conserve the number of nucleons is presented. The decay modes considered release charged particles with energies generally in excess of 100 Mev. A detector containing 198 liters of liquid scintillator was constructed to detect possible decay events. A Cherenkov counter anticoincidence shield consisting of a water tank 2.7 m in diameter and 2.2 m high viewed by photomultiplier tubes surrounded the detector and the experiment was carried out in a salt mine 585 m underground to reduce cosmic ray background. The system was set to detect pulses as low in energy as 8 Mev. The lifetime limits obtained for various decay modes were from 20 to 30 times greater than the best previous limits, and ranged from 1.3×10^{26} to 70×10^{26} years. (P.C.H.)

13466 UPPER BOUNDS ON SCATTERING LENGTHS AND LOW ENERGY PROTON-DEUTERON AND NEUTRON-DEUTERON SCATTERING. Kalman Kalikstein. Thesis, New York, New York Univ., 1962. 84p.

A recently developed, variational principle which is a minimum principle and assumes a particularly simple form at zero energy at the same time was applied to the determination of an upper bound on the scattering length, A, for any one channel scattering process. p-d scattering for an angular momentum (L) of zero and of one is considered. n-d scattering is obtained from p-d results by letting the Bohr radius, a, go to infinity. For L = 0, V(r) is taken to be a Gaussian central potential with parameters chosen to fit the two-body data; an arbitrary linear combination of the four usual exchange potentials is used. The Christian-Gammel deuteron wave function, R_ϕ is used. The scattering function taken for the ^4S p-d state is $\Psi_s = (1-P)R_\phi(r)E(q)x_Q$. r is the separation of the neutron and one of the protons, q is the distance between the other proton and the center of mass of the deuteron, P is the proton space exchange operator, E(q) is the modified Clifford-Bessel function, and x_Q is a quartet spin function. Using different choices of the relative strengths of the various exchange potentials, we find A $\leq$ 16.7 to 17.8 fermis, as compared to the Christian and Gammel estimate of 12.5 $\pm$ 1.0 fermis obtained from an analysis of the experimental data. The p-d results are markedly improved by using a more flexible scattering function, Ψ_s, of the form $\Psi_s = (1-P)\phi(r)[E(q) + Q(q)/q]x_Q$, where $\phi(r)$ is the zero-range deuteron function and $Q(0) = 0$, $Q(\infty) = 0$. The zero-range approximation simplifies the calculations. With this trial function we find for the ^4S state $A_{p-d} = 12.8$ and $A_{n-d} = 6.0$ fermis, as compared with the experimental values 12.5 $\pm$ 1.0 and 6.2 $\pm$ 0.2 fermis, respectively. (P.C.H.)

13467 THE MANY CHANNEL N OVER D METHOD IN DISPERSION RELATIONS AND ITS APPLICATION TO $\overline{K}$-N SCATTERING. Arthur Wesley Martin, III. Thesis, Stanford, Calif., Stanford, Univ., 1962. 203p.

An analysis was made of the many channel N over D method in detail, presenting a symmetrized formulation that overcomes certain drawbacks, and the symmetrized N over D technique was applied by means of a simple approximation scheme, to the scattering of $\overline{K}$ mesons by nucleons. The single channel method is discussed in detail both as an exact and as an approximate method. Approximation and renormalization techniques are analyzed and an interpretation of the physical significance of the method is presented in terms of Feynman diagrams. Finally, the parameterization and the extension of the single channel formalism to inelastic processes is discussed along with the effect of the C.D.D. ambiguity in dispersion relations on the method. Generalization of the single channel method to many channel processes is also carried through, and parameterization and the uniqueness of the many channel formalism are discussed. The symmetrized many channel N over D method is applied to $\overline{K}$-N scattering in the low energy region. The dynamic singularities of the scattering matrix are approximated by first Born approximation in the Yukawa interactions and the exchange of vector mesons separately. It is shown that the s-wave scattering lengths can be understood in terms of a resonance-like behavior near the $\overline{K}$-N threshold in the s-wave amplitudes. The branching ratios for threshold $\overline{K}$-N scattering are calculated and compared with experiment. (P.C.H.)

13468 LOW ENERGY OPTICAL POTENTIALS FOR NEUTRON AND A-PARTICLE SCATTERING FROM HEAVY NUCLEI. Walter Elisha Ware. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 271p.

The problem of a neutron with momentum greater than the Fermi momentum, interacting with nucleons in a Fermi distribution is treated. The Schroedinger equation describing the relative motion of the two-body problem was derived and found to be identical with the Bethe-Goldstone equation, which is the corresponding equation when both members of the interacting pair belong to the Fermi distribution. It is shown that the vanishing or non-vanishing of the two-body scattering amplitude depends critically upon the direction of the final relative momentum vector when one particle has momentum $k > k_F$, whereas the scattering amplitude vanishes for all directions of this vector when $k < k_F$. The single-particle potential for a neutron with laboratory en-

ergy greater than zero, moving through nuclear matter, was calculated and the result applied to finite nuclei in the Fermi-Thomas approximation. The optical potential thus found was essentially energy independent and has about the depth indicated by phenomenological analyses. The analogous problem of a Λ-particle interacting with nucleons in a Fermi distribution is also considered. The two-body Schroedinger equation was derived and found to be different from the Bethe-Goldstone equation. The scattering amplitude arising from this equation is shown to be non-zero only for very particular directions of the final relative momentum vector. A partial-wave analysis of this two-body equation was made, and it was found that orbital angular-momentum eigenstates do not exist but instead, all partial waves are mixed together. The single particle potential for a Λ-particle with energy greater than zero, moving through nuclear matter, was calculated and extended to finite nuclei with the Fermi-Thomas approximation. The depth of the Λ-nucleus optical potential was essentially energy independent in the range zero to twenty Mev but the depth depends critically on the range of the Λ-nucleon potential, which is not a well known quantity. (Dissertation abstr., 23: No. 16, Dec. 1962)

Neutron Physics

13469 (AE-89) ON THE SOLUTION OF THE NEUTRON TRANSPORT EQUATION. S. Depken (Aktiebolaget Atomenergi, Stockholm). Dec. 1962. 45p.

The Boltzmann equation for the scattering and slowing down of neutrons in an infinite medium is presented, and relations are derived to simplify solution of the neutron transport equation. An alternate form of the slowing down equation is given, and the slowing down function is examined. Results are applied to the case of large energy lethargy, and the validity of the derived formulas is discussed. (D.C.W.)

13470 (NYO-9657) SPATIAL DISTRIBUTION OF THE NEUTRON FLUX ON THE SURFACE OF A GRAPHITE-LINED CAVITY. J. T. Madell, T. J. Thompson, A. E. Profio, and I. Kaplan (Massachusetts Inst. of Tech., Cambridge). Apr. 1962. Contract AT(30-1)-2344. (MITNE-18). 336p.

A graphite-lined cavity is built at the outer end of the thermal column of the MIT Reactor. Seven variations of the material and geometrical arrangement of the cavity are made. The neutron flux is measured on the top surface and in the top wall of each variation and also on all surfaces and in the cavity itself of one of the variations. Absolute flux, cadmium ratio, and albedo measurements are made. The experimental results demonstrated that the cavity suitably modifies the magnitude, distribution, and direction of the neutrons emerging from the thermal column. A theoretical model is developed to calculate the magnitude and distribution of the neutron flux on the surfaces of a cavity. The values of the view factors and the albedos, that are necessary to calculate the flux in the cavities, are obtained from computer programs. The values of the flux are also calculated by using an electronic computer. The calculated values of the flux are in excellent agreement with the measured values, and it is felt that the use of the theoretical model is justified. (auth)

13471 (RT/FI(62)-57) DISTORSIONE DELLO SPETTRO DEI NEUTRONI TERMICI IN UN MODERATORE ORGANICO DI DIMENSIONI FINITE. (Distortion of the Thermal Neutron Spectrum in a Finite Organic Moderator). R. Scozzafava and G. Traversa (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia). Dec. 1962. 15p.

By taking into account the effects of leakage and absorption, the distortion of the thermal neutron spectrum in a finite organic moderator can be expressed by an integral equation of the Fredholm type. This equation is discussed for the case of 1/v absorption, and a particular solution of the equation leads to the numerical value of the diffusion cooling coefficient. (auth)

13472 NEUTRON-SPECTRUM MEASUREMENTS IN URANIUM–WATER AND URANIUM–MONOISOPROPYL DIPHENYL LATTICES. V. I. Mostovoi, V. S. Dikarev, M. B. Egiazarov, and Yu. S. Saltykov. At. Energ. (USSR), 13: 547-55(Dec. 1962). (In Russian)

Previous neutron spectrum determinations in heterogeneous U–H_2O systems yielded valuable information concerning the distribution of the neutrons in the fuel and the moderator, without however, clarifying the theoretically important neutron spectrum changes. An attempt was therefore made to collect detailed data on the spatial and energy distribution of the neutrons for the purpose of determining the laws governing the thermalization process. The spectra were determined in U–H_2O and U–monoisopropyl diphenyl systems by means of a chopper and a time-of-flight analyzer, using the water-cooled, water-moderated VVR reactor for the experiments. Results obtained showed that the neutron spectrum in both the U and the moderator differs from the Maxwellian distribution, exhibiting a sudden change at the boundary while changing only slightly within the U or the moderator. A simple, semi-empirical function was derived for correlating the thermal neutron fluxes in these materials. The spectrum became harder in the U–monoisopropyl diphenyl lattice, as compared to the U–H_2O system; in the 0.005 to 0.25 ev region the average neutron velocities obtained were 3.13×10^5 cm/sec for the organic and 3.0×10^5 cm/sec for water while in the U the corresponding values were 3.62 and 3.16×10^5 cm/sec, respectively. This hardening was due to the increased absorption with respect to the moderator at the expense of the thermal utilization. (TTT)

13473 CALCULATION OF THE NEUTRON DIFFUSION IN PERIODIC LATTICES. G. Ya. Rumyantsev. At. Energ. (USSR), 13: 556-62(Dec. 1962). (In Russian)

Although the diffusion of neutrons in heterogeneous media was studied by several authors, the methods of homogenization of the heterogeneous media were not sufficiently well developed. A computing method is therefore proposed for calculating the neutron diffusion in periodic heterogeneous lattices, requiring the solution of the transfer equation only within the boundaries of a single cell. In order to simplify the method, only a one-dimensional lattice was considered in the approximation, but the boundary conditions were valid for an exact solution. An averaged macroscopic solution was presented for the purpose of carrying out the homogenization of the medium more conveniently. In cases in which the macroscopic diffusion takes place simultaneously in 2 directions, the solution of the problem in each cell consists of 4 components: even–even, uneven–even, even–uneven, and uneven–uneven partial solutions. (TTT)

13474 A THREE-GROUP METHOD FOR CALCULATING THE THERMALIZATION IN A HETEROGENEOUS REACTOR CELL. L. V. Maĭorov and M. S. Yudkevich. At. Energ. (USSR), 13: 563-7(Dec. 1962). (In Russian)

Calculation of the spatial and energy distributions of the thermal neutron density in heterogeneous reactor cells, of great importance for measuring the thermal utilization

coefficient, the average absorption cross section, or the diffusion coefficient, is greatly complicated by the temperature coefficient within the cell. A set of trial functions was derived therefore for the purpose of determining the spatial and energy spectrum of thermal neutrons in a two-zone cell of a heterogeneous reactor with a temperature gradient; the results were then compared with those obtained by means of a 15-group computation. It was concluded that the three-group computation used yields sufficiently accurate results for the cells considered. The method could be further generalized for application to multizone cells; the number of groups must be increased in that case but not to the extent proposed by G. Salame and F. Federichi (Nucl. Sci. Eng., 10: 190(1961)). (TTT)

13475 NEUTRON THERMALIZATION IN A REACTOR LATTICE. R. Bonalumi (CISE, Milan). Energia Nucl. (Milan), 10: 1-15(Jan. 1963). (In English)

Studies were made of neutron thermalization in a reactor lattice where moderation may occur also outside the main moderator. Use was made of a first flight collision probability method where the moderator receives an ad hoc treatment. In the case of a two-region, two-temperature lattice, the analytical solution of the problem was carried through leading to working formulas, whose applicability was tested by the comparison with some experimental results. (auth)

13476 ON THE DISTRIBUTION OF THE SLOWING-DOWN TIME OF NEUTRONS. Takashi Nakayama (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 4: 834-7(Dec. 1962). (In English)

The distribution of the slowing-down time of neutrons in an infinite homogeneous medium is determined by the stochastic method. It is found that the distribution approaches that of gamma type asymptotically for a sufficiently large lethargy. The experimental results agree with theoretical curves. (auth)

13477 SUPPRESSION OF TOTAL REFLECTION OF NEUTRONS FROM COLLIMATOR SURFACES. Ian R. Jones and William Bartolini (Univ. of California, Livermore). Rev. Sci. Instr., 34: 28-30(Jan. 1963). (UCRL-7038)

Well-defined beams of thermal and long-wavelength neutrons are difficult to obtain because of reflection from collimator surfaces. Reflection is minimized if the product of the number of scatter centers per cm^3 and their net coherent scattering amplitude is as small a negative number as possible. This amplitude balancing can be achieved to almost any degree by the proper selection of organic compounds. When used as surface coatings, these compounds possess distinct advantages over other materials. Tetradecanoic acid ($C_{14}H_{28}O_2$) shows extremely low reflectivity and excellent properties as a surface coating. (auth)

13478 THEORY OF INELASTIC MAGNETIC SCATTERING OF SLOW NEUTRONS IN DOPED FERROMAGNETS. V. N. Kashcheev (Physics Inst., Riga). Soviet Phys.-Solid State (English Transl.), 4: 1494-1500(Feb. 1963).

A theory is offered for the energy distribution of one-magnon magnetic scattering of slow monochromatic neutrons in ferrodielectrics containing small concentrations of dia- and paramagnetic impurities. (auth)

Nuclear Properties and Reactions

13479 (AE-99) THE EFFECTIVE RESONANCE INTEGRAL OF THORIUM OXIDE RODS. J. Weitman (Aktiebolaget Atomenergi, Stockholm). Dec. 1962. 41p.

The effective resonance integral of thorium oxide rods was determined as a function of their surface to mass ratio. The range of S/M values covered is 0.15–0.65 cm^2/g. An experimental technique based on the comparison of activities obtained in thermal and slowing-down neutron fluxes is employed. The shape of the resonance neutron spectrum is determined from measurements with a fast chopper and from calculations, permitting deduction of a correction factor that relates the experimental values to the ideal 1/E case. The results are summarized by the following expression: $RI_{ThO_2} = (5.0 + 15.6\sqrt{S/M_{ThO_2}}) \pm 5.0\%$. The main contribution to the margin of error arises from the uncertainties in the 2.5% spectral correction applied in the 1.5 b "1/v" part deducted and in the 1520 b infinite dilution integral of gold, used as a standard. In order to compare the consistency of Dresner's first equivalence theorem and Nordheim's numerical calculations relative to our results, the resonance integral values for thorium metal rods obtained previously by Hellstrand and Weitman have been recalculated, using recent cross section and spectrum data. The new formula is $RI_{Th} = (3.3 + 16.1\sqrt{S/M_{Th}}) \pm 5.0\%$. It differs from the old one mainly because of the proved non-1/v behavior of the thorium cross section below the first resonance. Data and comparison of results with other experimental and theoretical results are given. (auth)

13480 (AFOSR-2929) A STUDY OF THE INTERNAL FIELDS ACTING ON NUCLEI IN SOLIDS USING THE TECHNIQUES OF THE MÖSSBAUER ABSORPTION AND PERTURBATION OF γ-γ CASCADES. Annual Summary Report, [January 1, 1961–December 31, 1961]. S. G. Cohen (Hebrew Univ., Jerusalem). Jan. 22, 1962. Contract AF61 (052)-347. 8p. (AD-277610)

Study of the internal fields acting on nuclei in solids is being carried out using Mössbauer absorption and perturbations of γ-γ cascades. γ-γ correlation experiments using Eu^{152} decaying to Sm^{152} show a temperature dependence of the attenuation coefficients of the correlation, justifying assumption of time dependent perturbations. Rotation of the correlation pattern from Eu^{152} decay in an external magnet field is noted to be also temperature dependent. For Tb^{160} in an external transverse field an angle of rotation of 85° in the negative direction is found as predicted, and an attenuation coefficient of 0.58 ± 0.12 is obtained. A gyromagnetic ratio of $g(Dy^{160}, 2+) = 0.32 \pm 0.09$ is found, and measurements on time dependence of angular correlation of Dy^{160} cascades is reported. (D.C.W.)

13481 (BLG-142) TABLES OF 12-j COEFFICIENTS. L. Buyst (Brussels. Centre d'Etude de l'Energie Nucléaire). Oct. 1962. 42p.

The 12-j coefficients used in nuclear physics are defined by: $(-)^{c-d}\ \Sigma_x\ (2x + 1)\ W(ajbj; xc)\ W(bjfj; xd)\ W(fjj'e; xj')\ W(j'eaj; xj)$ with $x = \frac{1}{2}, \frac{3}{2}, \frac{5}{2} \ldots$ where the W's stand for Racah-coefficients. The coefficients are calculated for the following values of the couple (j, j'): $(\frac{3}{2}, \frac{3}{2})$; $(\frac{3}{2}, \frac{5}{2})$; $(\frac{3}{2}, \frac{7}{2})$; $(\frac{3}{2}, \frac{9}{2})$; $(\frac{5}{2}, \frac{5}{2})$; $(\frac{5}{2}, \frac{7}{2})$; $(\frac{5}{2}, \frac{9}{2})$. (auth)

13482 (BNL-5876) CORRELATION OF FISSION-FRAGMENT KINETIC-ENERGY FINE STRUCTURE WITH SEMI-EMPIRICAL MASS SURFACE. R. Vandenbosch (Argonne National Lab., Ill.), and T. D. Thomas (Princeton Univ., N. J. and Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 13p.

An analysis of fine structure data is presented in which it is shown that there is a correlation between the observed fine structure and the semi-empirical mass surface. It is noted that if the mass surface is correct, the structure is found by observing events corresponding to a high enough

total kinetic energy such that some modes are energetically forbidden. (J.R.D.)

13483 (CEA-2216) DIFFUSIONS DES NEUTRONS DE 14 Mev SUR LE CARBON 12. DISTRIBUTIONS ANGULAIRES. (Scattering of 14 Mev Neutrons by Carbon-12. Angular Distributions). J. Duclos, M. Dubus, P. Perrin, I. Szabo, and R. Bouchez (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Grenoble and Grenoble, France. Université). 1962. 21p.

The angular distributions of neutrons from the reaction C^{12} (n,n') C^{12*} (Q = 0, 4.43, 7.65, and 9.63 Mev) have been measured from 10 to 120°, employing 14.5 Mev incident neutrons. The elastic and inelastic first-level angular distributions are in good agreement with recent measurements. The inelastic second level angular distribution has an important minimum around 45°. The inelastic third level angular distribution is nearly isotropic. Time of flight techniques are used, results are displayed, and equipment diagrams are included. (auth)

13484 (EFINS-62-79) RECOIL PROPERTIES OF Bi^{209}(p,pxn) SPALLATION PRODUCTS. William R. Pierson and Nathan Sugarman (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies and Chicago. Univ.). [1962]. Contract [AT(11-1)-1167]. 55p.

Recoil properties of products of Bi^{209}(p,pxn) reactions at a bombarding proton energy of 450 Mev were measured and compared with those predicted from the Monte Carlo cascade calculations of Metropolis et al. Agreement is good, although it appears that the calculation overestimates the transverse momentum component and does not predict as rapid a change in this component with mass number as that observed. The effect on the results caused by scattering of the recoiling nuclei during the stopping process is shown to be important. Approximate values for the yield ratio Bi^{205}/Bi^{206}, Po^{205}/Bi^{205}, and Po^{206}/Bi^{206} are presented. The latter two seem higher than those previously reported. Data and calculated results are shown. 60 references. (auth)

13485 (JINR-E-1145) QUASIOPTICAL APPROACH IN QUANTUM FIELD THEORY. A. A. Logunov and A. N. Tavkhelidze (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 17p.

An optical nuclear model that treats nuclear scattering by nuclei as the scattering of light by a semi-transparent medium considers scattering as a problem of nucleon motion in a complex potential field. A quasioptical approach to elementary particle scattering by quantum field theory concepts is derived. Quantum theory makes possible construction of the generalized complex potential dependent on velocities. Lippmann-Schwinger methods are extended to the complex potentials, and the Schrödinger equation with complex potential is constructed. (D.C.W.)

13486 (JINR-P-1119) γ IZLUCHENIE YADER S VYSOKIM SPINOM. (γ Radiation of Nuclei with High Angular Momentum). Yu. Ts. Oganesyan, Yu. V. Lobanov, B. N. Markov, and G. N. Flerov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1962. 14p.

A one crystal scintillation spectrometer is used to study the energy spectra of γ radiation arising in the interaction of the accelerated ions of O^{16} and Ne^{22} with the nuclei of Cu, Ta, W, and U in the energy range of 74–145 Mev. About 13 gamma-quanta with an energy of 0.7–1.1 Mev are observed per decay of a compound nucleus. The effect of the excited nucleus spin on the decay mechanism is discussed. (auth)

13487 (JINR-P-1130) O SHIRINAKH NEITRONNYKH REZONANSOV. (On Widths of Neutron Resonances). B. N. Zakharev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 7p.

On the basis of a double oscillator model (two particles in the field of an oscillator interact by an oscillatory potential) an energy distribution is obtained for individual particles. This distribution makes it possible to estimate the width of the neutron resonance in the simple model when the incident neutron interacts with only one nucleon in a nucleus. It turns out that the interactions with only one particle suffice to account for the fact that neutron widths Γ_n may be narrower than the radiation Γ_γ (i.e., the neutron even in such a simple model may be kept in a nucleus for a long while). (auth)

13488 (NDL-TR-40) REVISED CROSS SECTIONS FOR NEUTRON INTERACTIONS WITH OXYGEN AND DEUTERIUM. Final Report. M. H. Kalos, H. Goldstein, and J. Ray (United Nuclear Corp. Development Div., White Plains, N. Y.). Aug. 31, 1962. Contract DA-18-108-CML-7156. 19p. (UNC-5038)

A revision of the data for angular distributions for elastic neutron scattering in oxygen and deuterium is presented. The kinetics of the (n,2n) reaction in deuterium is discussed and a Monte Carlo scheme for generating the energy and direction of secondary neutrons is given. Complete sets of the cross sections for both materials are tabulated. (auth)

13489 (NP-12519) THE NUCLEAR PROPERTIES OF RHENIUM. Twelfth Quarterly Technical Progress Report, September 8, 1962 through December 8, 1962. R. A. Karam, T. F. Parkinson, W. H. Ellis, and E. E. Menge (Florida. Univ., Gainesville). Dec. 8, 1962. Contract NOas 60-6021-c. 18p.

A complete decay scheme of Au^{198} and Au^{196*} (excited state) is proposed. This decay scheme is based on shell model calculations and experimental measurements of the emitted gamma rays from Au^{198} and Au^{198*}. The half life of Au^{196*} was found to be 10.4 hours. The absolute intensity of each gamma ray associated with the decay of Au^{198} and Au^{196*} was obtained. (auth)

13490 (NYO-10252) A STUDY OF THE REACTION MECHANISM OF THE C^{13}(d,n)N^{14} AND C^{13}(d,p)C^{14} REACTION BETWEEN 3.2 AND 4.1 Mev. V. K. Deshpande (Rochester, N. Y. Univ.). Dec. 17, 1962. Contract AT(30-1)-875. 26p.

Angular distributions and excitation curves were obtained for the C^{13}(d,n)N^{14} and C^{13}(d,p)C^{14} reactions between 3.2 and 4.1 Mev. Angular distributions of both protons and neutrons show a strong peak at about 25°, typical of stripping with $l = 1$ for the captured nucleon. The (d,n) distributions also show a secondary maximum of about 80° that does not show up in (d,p) distributions. The excitation curves are flat except for a weak resonant structure at 3.4 Mev. Plane wave Butler theory does not account for the secondary maximum of the (d,n) distributions, and it overestimates absolute cross sections for both reactions. The distorted wave calculation gives a satisfactory fit to the (d,p) distribution at all angles but it predicts similar distributions for both (d,n) and (d,p) reactions, contrary to the experimental result. The compound nucleus formation does not seem to be an important participating mechanism. The possibility that the odd $P_{\frac{1}{2}}$ neutron of the C^{13} nucleus might be a participant in the (d,n) reaction is explored. The heavy particle stripping mechanism predicts angular distributions changing rapidly with energy, a feature not observed in the experiment. The angular distribution calculated on the basis of

exchange stripping mechanism for $C^{13}(d,n)N^{14}$ reaction has the feature of the secondary maximum. Although this calculation is made with the plane wave approximation it gives some indication that the odd $P_{\frac{1}{2}}$ neutron in C^{13} may be a participant in the reaction. (auth)

13491 QUASI-FREE SCATTERING OF 155-Mev PROTONS ON PROTONS OF LIGHT NUCLEI. Jean-Pierre Garron (Faculté des Sciences, Paris). Ann. Phys. (Paris), 7: 301-27(May-June 1962). (In French)

The (p,2p) reaction on Li^6, Li^7, Be^9, B^{10}, B^{11}, and C^{12} was studied by fixing for the two protons detected in coincidence simple kinematic conditions. An attempt is made to define the information that can be deduced with respect to the structure of these nuclei, beginning with the sum energy spectra of the two protons and the angular correlations. The theoretical principles of the study and the experimental apparatus are described in detail. The results show that there is generally a qualitative agreement with the predictions of the shell model. The variations from the shell model predictions are discussed for each isotope. (J.S.R.)

13492 ANALYSIS OF THE EXCITATION FUNCTIONS OF THE LEVELS OF THE Fe^{56} NUCLEUS IN CASE OF INELASTIC NEUTRON SCATTERING BY THE OPTICAL NUCLEAR MODEL. D. A. Kardashev, V. S. Stavinskiĭ, D. D. Broder, A. I. Lashuk, and I. P. Sadokhin. At. Energ. (USSR), 13: 587-8(Dec. 1962). (In Russian)

The excitation functions of the individual levels of the Fe^{56} nucleus were measured for the case of the inelastic scattering of 0.8- to 4.0-Mev fast neutrons. The experimental data were compared with the results of calculations made by the methods of W. Hauser and H. Feshbach (Phys. Rev., 87: 366(1952) and P. E. Nemirovskiĭ (Zh. Eksperim. Teor. Fiz. 39: 1737(1960)). The γ spectrum from the inelastic scattering process was measured by means of a NaI(Tl) spectrometer, able to measure γ quanta with formation cross sections exceeding 0.015 barn. The excitation cross section of the 2.87 level at the 3.2- to 4.0-Mev energy region was found to be about 0.15 to 0.2 barn; no γ quanta corresponding to the excitation of this level were found; thus the excitation cross section of this level was estimated to be below 0.015 barn. The data indicated that the 2.87-Mev level is either absent or that a spin larger than 2^+ must be used. There are no data concerning excitation in the range from 4 to 5 Mev. The optical model with a regularly decreasing potential at the grain boundary makes it possible to reproduce the level excitation functions for inelastic scattering in the energy ranges in which the excitation parameters of the target atom are known. (TTT)

13493 A NOMOGRAM CONSTRUCTED FROM EQUALIZED POINTS FOR DETERMINING THE CORRELATION BETWEEN THE ESCAPE ANGLES OF NUCLEAR REACTION PRODUCTS. G. N. Potetyunko. At. Energ. (USSR). 13: 588-91(Dec. 1962). (In Russian)

The equalized points method was used widely for the preparation of nomograms showing kinematic relations in nuclear reactions. A parametric expression was derived, indicating the dependence of escape angles of nuclear products on the mass of the particles participating in the reaction and on the energy of the escaping particles. These factors are considered as two independent variables in the construction of the nomogram, details of which are given. (TTT)

13494 THE HALF-LIFE OF CESIUM-137. D. G. Fleĭshman, I. V. Burovina, and V. P. Nesterov. At. Energ. (USSR), 13: 592-3(Dec. 1962). (In Russian)

The decay rate of Cs^{137} was determined by measuring the β activity with a liquid scintillator containing 2,5 diphenyl oxazole, 1,4 [di-2,5 phenyl oxazole]-benzene and naphthalene in dioxane and making use of the isotopic dilution method for the quantitative determination of the material. The aqueous solution of $CsNO_3$ is miscible with the dioxane-base scintillator, thus eliminating the problems caused by the absorption and self-absorption of the β particles which were counted with about 93% efficiency. The absolute activity of the solution was obtained by extrapolating to zero energy the integrated spectrum curve which was measured by means of a fast amplitude analyzer. The total error, including the extrapolation and γ quantum determinations, did not exceed 2%. The half life of Cs^{137} was calculated at 30 ± 0.7 years, agreeing well within the limits of error with the previously reported $T_{\frac{1}{2}}$ values of 29 ± 1 and 30 ± 0.4 years. (TTT)

13495 CALCULATION OF BUILDUP FACTORS FOR γ-RADIATION IN HETEROGENEOUS MEDIA. D. L. Broder, Yu. P. Kayurin, and A. A. Kutuzov. At. Energ. (USSR), 13: 593-5(Dec. 1962). (In Russian)

The applicability of the authors' semi-empirical formula for calculating the buildup factor of the Co^{60} γ radiation in heterogeneous media (At. Energ., 12: 20(1962) No. 1) to energies of 2.76 and 6.4 Mev was investigated, using Na^{24} as the source of the 2.76-Mev γ quanta. The attenuation factors for the 2.76- and 1.38-Mev lines, the only ones considered, were taken from U. Fano's work (Nucleonics 11: 8(1953) No. 8). The $F^{19}(p,\alpha)O^{16}$ reaction was used to obtain the 6.4-Mev γ quanta by accelerating the protons in a linear accelerator to 0.88 Mev and directing them onto a CaF_2 crystal. Comparison of the experimental and theoretical data indicated that the cited formula is applicable in the energy range from 1 to 6.5 Mev; it might be possible to use it at even higher energies. (TTT)

13496 ASSIGNMENTS OF THE ^{35}Cl NUCLEAR QUADRUPOLE RESONANCE SPECTRA IN MULTICHLOROBENZENES BY THE MEASUREMENT OF THE ZEEMAN EFFECT. Yonezo Morino, Masaharu Toyama, Koichi Itoh, and Saburo Kyono (Tokyo Univ.). Bull. Chem. Soc. Japan, 35: 1667-73(Oct. 1962).

Assignments of the Cl^{35} nuclear quadrupole resonance spectra were made for some polychlorobenzenes by Zeeman studies of single crystals. Three resonance lines in 1,3,5-trichlorobenzene were assigned, in the order of increasing frequency, to Cl_3, Cl_1, and Cl_2; 2 lower frequencies in 1,2,3,4-tetrachlorobenzene to Cl_1 and Cl_4 and 2 higher ones to Cl_2 and Cl_3; and in pentachlorobenzene, the second highest frequency to the chlorine atom at the para position with respect to the single hydrogen atom. Shifts of the resonance frequencies were accounted for in terms of the induction effect. It is likely that the ortho effect is produced by the direct field arising from the charges on the neighboring atoms rather than the indirect one propagated through the chemical bonds. The interpretation of the 3 frequencies in 1,3,5-trichlorobenzene was also attempted from the viewpoint of the intermolecular effect. It was suggested that an induction effect independent of the directions takes place in the crystal among the neighboring molecules. (P.C.H.)

13497 EXCITATION CURVES FOR THE REACTIONS $Al^{27}(n,\alpha)Na^{24}$ AND $Mg^{24}(n,p)Na^{24}$. J. P. Butler and D. C. Santry (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 41: 372-83(Feb. 1963). (AECL-1660)

Excitation curves for the reactions $Al^{27}(n,\alpha)Na^{24}$ and $Mg^{24}(n,p)Na^{24}$ are measured by the activation method from near-threshold energies to 20.3 Mev. The measurements are relative to the cross section for the reaction $S^{32}(n,p)P^{32}$. Monoenergetic neutrons are obtained from the $D(d,n)He^3$,

T(d,n)He^4, and T(p,n)He^3 reactions. Cross sections for both reactions rise above the minimum detectable value of 0.02 mb near 5 Mev and reach maximum values of 126 mb for the $Al^{27}(n,\alpha)Na^{24}$ reaction and 205 mb for the $Mg^{24}(n,p)Na^{24}$ reaction at 13.5 Mev. Above this energy both cross sections decrease. From the excitation curves, effective cross-section values for a fission-neutron spectrum are calculated as 0.61 ± 0.03 mb for the (n,α) reaction and 1.34 ± 0.07 mb for the (n,p) reaction. (auth)

13498 RESULT OF CALCULATIONS OF ANGULAR DISTRIBUTION WITHOUT DISTORTED WAVES ON SILICON-29. Edgard Elbaz and Joseph Lafoucrière Compt. Rend., 255: 2591-3(Nov. 12, 1962). (In French)

A calculation of the angular distributions of "stripping" is made not using distorted waves but a complementary interaction of the proton emerging with the residual nucleus. The application to Si^{29} agrees very well with the experimental results of Sukhrevskii. (tr-auth)

13499 RELATIVE CROSS-SECTIONS FOR THE $^{127}I(d,p)$ REACTION. D. J. Silvester (Medical Research Council, London) and G. C. Jack. J. Inorg. Nucl. Chem., 24: 1181-4(Dec. 1962).

Yields of I^{128} from the $I^{127}(d,p)$ reaction were measured for deuteron energies up to 14.8 Mev relative to the yield at 9.98 Mev. In agreement with calculation, the results indicate that the cross section for this reaction reaches a maximum value at about 11 Mev. (auth)

13500 FISSION OF ^{232}Th BY 9.5 Mev DEUTERONS: YIELD-MASS CURVE. M. V. Ramaniah and Arthur C. Wahl (Washington Univ., St. Louis). J. Inorg. Nucl. Chem., 24: 1185-9(Dec. 1962).

Relative yields for sixteen fission products from fission of Th^{232} induced by 9.5 Mev deuterons are reported. The yield-mass curve drawn to fit these yields is double humped, has a trough-to-peak ratio of 0.15, and is symmetrical about A = 115. The heavy mass peak is in essentially the same position on the A-axis as the heavy mass peak for thermal-neutron fission of U^{235}; the position of the light mass peak is 2 to 3 mass units lower in A than that of the U^{235} light mass peak. An analysis of the curve indicates that most fissions result from capture of the entire deuteron and that the average number of prompt neutrons emitted is 4 ± 1. (auth)

13501 MATHEMATICAL DEDUCTIONS FROM SOME RULES CONCERNING HIGH-ENERGY TOTAL CROSS SECTIONS. C. N. Yang (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 4: 52-3(Jan. 1963). (BNL 6294)

Mathematical implications of the Pomeranchuk rule and the Pomeranchuk-Okun rule are discussed. (auth)

13502 THE CROSS SECTION OF THE $^{58}Ni(n,p)^{58}Co$ REACTION FOR NEUTRONS IN THE ENERGY RANGE 1.6 TO 14.7 Mev. J. F. Barry (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. A and B, 16: 467-72(Oct. 1962).

The cross section of the reaction $Ni^{58}(n,p)Co^{58}$ is measured at several neutron energies in the range 1.6 to 8.3 Mev and at 14.8 Mev. The Co^{58} produced in the reaction is determined by counting the γ rays from its decay and the neutron flux is measured with a U^{235} fission counter. The cross section rises from threshold to a value of 657 mb at 8.3 Mev. At 14.8 Mev the cross section is 290 mb. The calculated mean cross section for fission spectrum neutrons from these results is (111 ± 12) mb. (auth)

13503 LOW EXCITED STATES OF O^{16}. [PART] I. R. Berenbaum (Atomic Power Construction Research and Development, Heston, Middlesex, Eng.) and M. Umezawa. Nucl. Phys., 39: 177-97(Dec. 1962). (In English)

Some general characteristics of the particle-hole energy are discussed by using a simple model. Energy levels of the O^+ excited states caused by the excitation of a single nucleon are estimated for O^{16} and Ca^{40}. Monopole transition probabilities of these excited states are also estimated and compared with the experimental results. The energy level spacing between the 0^+ and 2^+ excited states of O^{16} is roughly estimated assuming the excitation of a single nucleon. The transition probability from this level to the ground state is calculated and is found to agree with experiment. Also the ratio of the two transition probabilities from the 2^+ excited state to the 0^+ excited and ground states is calculated and compared with experiments. The result obtained seems to suggest that it is necessary to take into account the two-particle excitation in order to explain the probability of the transition from the 2^+ excited state to the 0^+ excited state. Some remarks are made on the ratio of the transition probabilities of the decays from the 1^- state to the 0^+ excited and ground state, and also on the two-γ emission probability of the 0^+ excited state through the virtual excitation at the lowest 1^- state. (auth)

13504 STRUCTURE OF THE O^{16} NUCLEUS. Nazakat Ullah and R. K. Nesbet (Boston Univ.). Nucl. Phys., 39: 239-51(Dec. 1962). (In English)

An approximate Hartree-Fock self-consistent-field calculation is carried out for the ground state of the O^{16} nucleus. The two-body interaction used has a finite hard core as well as exchange interaction. Our zeroth-order wave function gives an improved ground state energy of −116.3 Mev as compared to −87.8 Mev obtained with harmonic oscillator wave functions in zeroth order in a previous calculation using the same hamiltonian. The calculated value of the r.m.s. radius is 2.07 fm. Coulomb forces are neglected in zero order and contribute 18.2 Mev when treated as a first order perturbation. A projection operator technique is used to construct $S^{1,1}$ wave functions from the various excited configurations that interact with the ground state. The configuration interaction calculation yields −13.6 Mev as the correlation energy, giving a total binding energy nearly identical with that obtained in an earlier calculation which used harmonic oscillator wave functions in zeroth order. Thus the net correlation energy is found to be very much smaller than would appear from the simple shell model. The tensor force does not contribute to the energy of the $S^{1,1}$ ground state configuration, and the configuration interaction effects from the tensor force are found to be quite small (≈ −0.2 Mev). The fact that total correlation energy including tensor force is small indicates that L-S coupling is a good approximation for the ground state of closed shell nuclei like O^{16}. The $P^{3,1}$ states arising from the configurations $p^{-1}d$ and $p^{-1}2s$ in L-S coupling are calculated. These states are associated with dipole resonance in O^{16}. The calculation shows that most of the dipole sum is obtained from two $P^{3,1}$ states. The methods of calculation described are quite general and can be applied easily to either open or closed shell nuclei, if the two-body interaction has no worse than an integrable singularity (integrable hard core). (auth)

13505 DISINTEGRATION OF ^{27}Mg. L. Ciuffolotti (SORIN, Centro di Ricerche Nucleari, Saluggia, Italy) and F. Demichelis. Nucl. Phys., 39: 252-62(Dec. 1962). (In English)

The β and γ spectra following the radioactive decay of Mg^{27} (half-life 9.5 min) are investigated by scintillation techniques. The sources are obtained by Mg(n,γ) reaction.

β-γ and γ-γ coincidences are investigated with a conventional coincidence set up and the spectra are displayed in a 200 channel analyzer. The level sequence of Al^{27} is discussed in terms of the rotational collective model. (auth)

13506 THE REACTION $Al^{27}(n,\alpha)Na^{24}$ AND $Co^{59}(n,\alpha)Mn^{56}$ WITH 14 Mev NEUTRONS. W. Patzak and H. Vonach (Inst. of Radium Research and Nuclear Physics, Vienna). Nucl. Phys., 39: 263-72(Dec. 1962). (In German)

The energy and angular distributions of the α particles from the reactions $Al^{27}(n,\alpha)Na^{24}$ and $Co^{59}(n,\alpha)Mn^{56}$ at 14 Mev were measured. From the energy distribution the nuclear temperature was determined as 1.5 and 0.9 Mev for Na^{24} and Mn^{56} respectively. It turned out to be a constant over the whole region of excitation energy measured. The angular distribution was nearly symmetrical to 90°, but in both cases there seemed to be a slight forward asymmetry. The result was compared with the statistical theory. From the anisotropy the moments of inertia for the residual nuclei could be determined. (auth)

13507 ANALYSIS OF EVIDENCE OF TWO CLASSES OF E1 TRANSITIONS IN DEFORMED NUCLEI OF RARE EARTHS. M. N. Vergnes (Laboratoire Joliot-Curie de Physique Nucléaire, Orsay, France). Nucl. Phys., 39: 273-85(Dec. 1962). (In French)

The experimental E1 transitions probabilities in odd-mass deformed nuclei in the rare earth region are compared to theoretical transition probabilities. The transitions between two intrinsic levels can be divided into two classes: in the first, characterized by $\Delta\Omega = 0$, the experimental probabilities are in good agreement with the theoretical previsions; in the second, characterized by $\Delta'\Omega = \pm 1$, the transitions are forbidden and this forbiddenness is shown to vary regularly with A. The considerable decrease of the forbiddenness for the transitions with $\Delta\Omega = 1$ between an intrinsic and a rotational level is presumably caused by the perturbation of the wave-function by the rotation of the nucleus. (auth)

13508 PRECISION ENERGY DETERMINATION OF ISOMERIC LEVELS AND OF LOW-LYING EXCITED STATES IN DEFORMED NUCLEI. Rune Hardell and Sam Nilsson (Chalmers Inst. of Tech., Goteburg). Nucl. Phys., 39: 286-99(Dec. 1962). (In English)

Precision determinations of gamma ray energies of short-lived ($T_{\frac{1}{2}} < 0.5$ h) isomeric transitions in Co^{60}, Rh^{104}, Dy^{165}, and Re^{188} are made with a bent-crystal diffraction spectrometer connected with a reactor by a pneumatic tube. Excited levels are also measured with the same instrument for the deformed nuclei Eu^{153}, Eu^{155}, Ho^{165}, Er^{166}, and Hf^{176}. (auth)

13509 SPIN ASSIGNMENTS IN Al^{27} FROM NEUTRON SCATTERING STUDIES. J. H. Towle and W. B. Gilboy (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 39: 300-17(Dec. 1962). (In English)

Differential cross sections for elastic and inelastic scattering of neutrons by Al^{27} are measured at 0.98, 2.01, 3.01, and 3.99 Mev. Inelastic scattering cross sections are also measured at 200 kev intervals from 1.4 to 3.0 Mev. A theoretical analysis of the data obtained at 3.99 Mev leads to spin assignments of $\frac{7}{2}$ and $\frac{9}{2}$ respectively for the excited states at 2.21 and 3.00 Mev. Consequently, it is likely that these are members of the $K = \frac{5}{2}$ rotational band based on the ground state. (auth)

13510 FINE STRUCTURE OF NUCLEAR MASSES IN α-DECAY. V. N. Andreev (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., 39: 318-24 (Dec. 1962). (In English)

Consideration of data on α-decay energies of heavy odd-mass nuclei with $A > 230$ leads to the conclusion that there exists a property of nuclei: fine structure of nuclear masses. This property is manifested in α-decay in that the energies of α-particles can assume, in the transition of the product nuclei into the ground state, only perfectly definite values smoothly depending on A and Z. The fine structure of nuclear masses also points to the connection of α-decay energy with the relative parity of the parent and product nuclei. (auth)

13511 α-PARTICLES EMITTED FROM 14 Mev NEUTRON INTERACTIONS WITH LIGHT AND MEDIUM-WEIGHT NUCLEI. O. N. Kaul (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 39: 325-34(Dec. 1962). (In English)

A study of α-particles emitted as a result of 14-Mev neutron interactions with Na^{23}, Mn^{55}, and As^{75} is undertaken by the emulsion technique making use of 200 μm Ilford C_2 plates. The energy distribution seems to be completely Maxwellian with a peak value ranging from 4 to 5 Mev alpha energy with an excessive emission of alpha particles on the low-energy side. The angular distribution in the c.m. system is anisotropic, but approximately symmetrical about 90°. A semi-log plot of relative level densities of the residual nuclei calculated from the alpha energy fits a straight line except on the low energy side where it becomes concave upwards; this curvature becomes more pronounced for higher mass numbers. The cross section for Mn^{55} is estimated to be $\approx$86 mb $\pm$ 10%. The temperature of the residual nuclei is found to be an increasing function of mass number. The results obtained in the cases of Na^{23}, Mn^{55}, and As^{75} are discussed. (auth)

13512 GAMMA RAYS FROM PROTON BOMBARDMENT OF ARGON. T. Wakatsuki, Y. Hirao, and I. Miura (Osaka Univ.). Nucl. Phys., 39: 335-45(Dec. 1962). (In English)

Gamma rays from the proton bombardment of argon were investigated using NaI(Tl) scintillators. The proton energy was about 5.6 Mev. Coincidence measurements with inelastically scattered proton groups were performed. The branching ratios of the decays from each excited state of Ar^{40} were determined. Direct transition from the 2nd to the ground states could not be observed. Angular correlation between the gamma ray from the 2nd to the 1st states of Ar^{40} and the proton group leading to the 2nd state of Ar^{40} was measured. The distribution was isotropic within a statistical error, about 4%. Gamma-gamma angular correlation between the cascade gamma rays from the 2nd state was measured. The result agreed with the calculated correlation curve of a 0-2-0 spin sequence. It was concluded that the spin of the 2nd state of Ar^{40} was 0^+. From the comparison of the observed branching ratios with the Moszkowski's single particle estimates, the 3rd state could have a spin of 1 or 2 and the 9th and the 11th states could have spins of 1 or 2 and 0, 1, or 2, respectively. From the result of neutron-gamma coincidence measurement, intense gamma rays of 0.77 and 1.14 Mev in the single spectra were found to be produced by the transitions between the states of K^{40} formed by the reaction $Ar^{40}(p,n)K^{40}$. (auth)

13513 GAMMA RAYS FROM THE CAPTURE OF FAST NEUTRONS IN Ag, Sn, I, AND Cs. I. Bergqvist and N. Starfelt (Research Inst. of National Defence, Stockholm). Nucl. Phys., 39: 529-34(Dec. 1962). (In English)

Spectra of the γ rays emitted when thermal neutrons and

neutrons of energies from 20 to 300 kev are captured in Ag, Sn, I, and Cs are measured. The shape of the γ spectra is found to be independent of neutron energy and thus of the angular momentum of the captured neutron. The discrepancy between experiment and simple statistical theory increases with increasing mass number in the same way as was observed for the elements Ta to Hg. (auth)

13514 SCATTERING OF FAST NEUTRONS BY ALUMINIUM. D. Winterhalter (Univ. of Zagreb). Nucl. Phys., 39: 535-40(Dec. 1962). (In English)

The energy spectra of 2.76 Mev neutrons scattered on aluminium are measured at 30°, 60°, 90° and 120°, by means of nuclear emulsion detectors. Discrete neutron groups, corresponding to nuclear levels of energy 1.013 Mev and 1.91 Mev are investigated. The total cross section for the emission of neutrons from aluminium is obtained by transmission measurement, and the result compared with an optical model calculation. (auth)

13515 THE SCATTERING OF PROTONS FROM He^3. T. A. Tombrello, C. Miller Jones, G. C. Phillips, and J. L. Weil (Rice Univ., Houston, Tex.). Nucl. Phys., 39: 541-50 (Dec. 1962).

The elastic scattering of protons from He^3 has been investigated from 2.0 to 4.8 Mev with the Rice University Van de Graaff accelerator and a small-volume, gas scattering chamber. Nine excitation curves were measured for center-of-mass angles between 39.23° and 166°, and angular distributions have been measured for proton energies of 2.01, 3.01, 3.99, and 4.54 Mev. The phase shifts derived from these experimental data and from the data obtained at other laboratories are compared with the theoretical calculations of Bransden and Robertson. These results tend to favor the Serber rather than the symmetrical type of exchange interaction for the nucleon-nucleon potential. (auth)

13516 NEUTRON AND PROTON PAIR INTERACTION ENERGY. P. E. Nemirovskii and Yu. V. Adamchuk (Atomic Energy Inst., Moscow). Nucl. Phys., 39: 551-62(Dec. 1962). (In English)

The pairing energies of two neutrons δ_n and two protons δ_p are calculated from the difference of the masses of odd-mass and adjacent even nuclei, taking into account the corrections for the difference in the surface and Coulomb energies as well as the symmetry energies in these nuclei. The problem of the additional energy of neutron and proton interaction is not considered. Tables of pair interaction energies are presented. (auth)

13517 PAIRING CORRELATION AND THE OPTICAL MODEL POTENTIAL. Tokuo Terasawa (Western Reserve Univ., Cleveland). Nucl. Phys., 39: 563-9(Dec. 1962). (In English)

The effect of the pairing correlation on the imaginary part of the nuclear optical model potential has been studied for the finite nucleus, mainly using the Thomas-Fermi gas model. It has been found that the imaginary potential is appreciably enhanced by this effect in the nuclear surface region for low-energy incoming neutrons and that, in particular, this increase is quite significant if a density dependent pairing correlation such as suggested by Emery and Sessler is used. (auth)

13518 ANHARMONIC EFFECTS OF QUADRUPOLE OSCILLATIONS OF SPHERICAL NUCLEI. S. T. Beliaev and V. G. Zelevinskii (Kurchator Atomic Energy Inst., Moscow). Nucl. Phys., 39: 582-604(Dec. 1962). (In English)

Deviations from the principal "harmonic" approximation are considered in the framework of the microscopic theory of the collective excitations of spherical even nuclei. It is shown that the "anharmonic" corrections are expressed through one parameter in the first approximation with respect to the parameter of adiabaticity. The corrections to the wave functions, energy levels and the E2 transition probabilities for the first two excited states are found in this approximation. Second order corrections are also obtained. The interaction of collective oscillations with other excitations (non-adiabaticity) is estimated. The excitations of the nuclei connected with the quadrupole oscillations of the outer neutrons with respect to the protons are considered. (auth)

13519 GAMMA-GAMMA ANGULAR CORRELATIONS IN THE $Cl^{35}(n,\gamma)Cl^{36}$ AND $Mo^{95}(n,\gamma)Mo^{96}$ REACTIONS. I. Lovas and Z. Zámori (Central Research Inst. for Physics, Budapest). Nucl. Phys., 39: 605-12(Dec. 1962). (In English)

To determine the spin and parity of excited levels arising from the 7.787-0.787 and the 7.409-1.165 Mev γ-γ cascades in the $Cl^{35}(n,\gamma)Cl^{36}$ reaction and from the 0.77-0.84 Mev cascade in the $Mo^{95}(n,\gamma)Mo^{96}$ reaction, the angular correlations of these cascades have been measured. Procedure followed is described and assignments of 0^+ and 2^+ are made for the 0.787 and 1.165 Mev levels in Cl^{36}. Assignments of 2^+ for the first excited level in Mo^{96} and a spin of 4^+ for the second are made. (D.C.W.)

13520 INTERNAL CONVERSION SPECTRUM OF I^{131} (8.06 d). J. L. Wolfson (National Research Council of Canada, Ottawa), J. J. H. Park, and L. Yaffe. Nucl. Phys., 39: 613-20(Dec. 1962). (In English)

The internal conversion spectrum of I^{131}(8.06 d) has been examined under moderate and high resolution. K and L lines have been observed due to weak transitions in Xe^{131} of 177.23 ± 0.03 kev, 325.78 ± 0.05 kev and 502.99 ± 0.08 kev. The energy measurements indicate that the first two are in cascade and that the third is a cross-over transition. The K/L ratio and L sub-shell ratios for the 177 kev transition indicate that this transition is E2 in character. From the K/L ratio, the 326 kev transition is probably either E2 or M2. More accurate energy values than heretofore available have been obtained for several of the other transitions in Xe^{131}. (auth)

13521 NEUTRON REACTIONS IN Al FROM 2.5 TO 5 Mev. G. Calvi, R. Potenza, R. Ricamo, and D. Vinciguerra (Università, Catania, Italy). Nucl. Phys., 39: 621-30(Dec. 1962). (In English)

The interaction of neutrons in the energy range 2.5 to 5 Mev in aluminium is studied by measuring the total cross section and the reaction cross sections for the (n,p) process and for the fast neutron radiative capture. Measurements are made in steps of about 25 kev for the total cross section and of about 50 kev for the (n,p) and (n,γ) cross sections with a neutron energy spread of about 50 kev in both cases. The structures of the cross sections are interpreted as due to statistical fluctuations of the level density of the Al^{28} intermediate nucleus. An estimate of an effective Al^{28} level density at an excitation energy E = 12.5 Mev is obtained from the fluctuations of the cross sections; the fit with the theoretical predictions is discussed. (auth)

13522 THE LOW ENERGY RESONANCES IN THE $P^{31}(p,\gamma)S^{32}$ NUCLEAR REACTION. I. Berkes, I. Dézsi, Ilona Fodor, and L. Keszthelyi (Central Research Inst. of Physics, Budapest). Nucl. Phys., 39: 631-43(Dec. 1962). (In English)

The γ-radiation of the first three resonances (E_p = 355, 440, and 540 kev) in the $P^{31}(p,\gamma)S^{32}$ nuclear reaction has been investigated. The angular distribution recorded for the 9-Mev γ radiation enabled spin and parity assignments of 1± to be made for the resonances both at the 9.185 and the 9 9.267 Mev levels. Analysis of the angular distribution of the 7-Mev radiation and of the angular correlation between the latter and the 2-Mev radiation shows that spin and parity of 2^+ can be assigned to the 9.367-Mev level. (auth)

13523 MECHANISM OF ELASTIC AND INELASTIC SCATTERING OF LOW ENERGY PROTONS FROM Ne^{20}. H. Hulubei, A. Berinde, I. Neamu, J. Franz, N. Martalogu, and M. Ivascu (Inst. of Atomic Physics, Bucharest). Nucl. Phys., 39: 686-93(Dec. 1962). (In English)

The elastic and inelastic angular distribution of protons scattered from Ne^{20} are measured at ten bombarding energies in the range 5.20–6.23 Mev. The shape of the inelastic angular distribution curves does not change appreciably with the energy, although the value of the cross-section suffers important variations. The elastic and inelastic scattering excitation functions vary with the energy in a compensating manner, the increase of the elastic cross-section being accompanied by a decrease of the inelastic cross-section and conversely. The experimental data are explained qualitatively in the light of Yoshida's direct interaction theory, which takes into consideration the coupling between the reaction channels. (auth)

13524 TWO-PROTON RADIOACTIVITY. THE NEW MODE OF SPONTANEOUS TRANSMUTATION OF ELEMENTS. V. I. Gol'danskii (Inst. for Chemical Physics, Moscow). Nuovo Cimento (10), 25: Suppl. No. 2, 123-60 (1962). (In English)

The basic characteristics of angular and energy correlation of protons in two-proton decay are considered. Information and possible estimates related to experimental investigation of the two-proton radioactivity are discussed. (C.E.S.)

13525 AUGER ELECTRONS ASSOCIATED WITH STOPPED π^- INTERACTIONS IN NUCLEAR EMULSIONS. J. E. Cuevas and A. G. Barkow (Marquette Univ., Milwaukee). Nuovo Cimento (10), 26: 855-68(Dec. 1, 1962). (In English)

The frequency of Auger electrons from π^- meson interactions in nuclear emulsion is determined. The energy distribution of Auger electrons from the light and heavy elements of the emulsion is obtained. The pion flux is $4 \cdot 10^4$ per cm per minute, and after traveling 1.5 cm of emulsion 95% of the π^- mesons stop within a strip 2 cm long. There are observed 5498 π^- meson interactions, out of which 950 have 1092 Auger electrons associated with them. Of the 950 Auger events, 863 are produced by π^- meson interactions with the heavy elements of the emulsion, and the remaining 87 result from the absorption of the π^- meson by the light elements of the emulsion. The frequency of events having one or more Auger electrons is observed to be 0.173 or 950/5498. The observed energy spectrum of the Auger electrons from the heavy and light elements of the nuclear emulsion is found to agree, within the experimental errors, with the calculated energy spectrum. It is also observed that 92% of all Auger electrons originate from heavy nuclei and 8% from light nuclei. (auth)

13526 A PHENOMENOLOGICAL APPROACH TO THE NONMESONIC DECAY OF $^5He_\Lambda$. P. G. Thurnauer (Clarendon Lab., Oxford). Nuovo Cimento (10), 26: 869-83 (Dec. 1, 1962).

Effective phenomenological interaction forms for the nucleon stimulation interaction are constructed from general invariance principles and are used to calculate momentum distributions, angular correlations, and the branching ratio for the two nonmesonic hyperfragment decay modes $_\Lambda He^5 \rightarrow H^3 + p + n$ and $_\Lambda He^5 \rightarrow He^3 + n + n$. It is found that the momentum distributions are sensitive to the range taken for the interaction, while the branching ratio may be used in determining the relative magnitudes of the terms appearing in the interaction. Also, neutron stimulation may contribute significantly to an essentially proton stimulated mode, e.g., $_\Lambda He^5 \rightarrow H^3 + p + n$, but this effect becomes increasingly negligible as the interaction range is extended. (auth)

13527 ANGULAR DISTRIBUTIONS IN THE REACTION $^4He(\gamma,p)^3H$. I. G. Main (St. Andrews Univ., Scotland). Nuovo Cimento (10), 26: 884-9(Dec. 1, 1962). (In English)

The angular distribution of over 3500 protons from the reaction $He^4(\gamma,p)H^3$ is measured in the photon energy range 23 to 32 Mev, using the photographic plate method. The distribution is described in the c.m. system by an expression of the form $f(\theta) = B(1 + C \cos\theta + D \cos^2\theta) \sin^2\theta$, with the value of C approximately equal to 0.5 and showing little appreciable variation with energy. The value of D is not very critical, even at the highest energies, and no constant term is necessary in $f(\theta)$. (auth)

13528 ENERGY SPECTRUM OF THE PHOTONEUTRONS FROM PHOSPHORUS. V. Emma (Università, Catania, Italy), C. Milone, S. Jannelli, and F. Mezzanares. Nuovo Cimento (10), 26: 890-5(Dec. 1, 1962). (In English)

The energy spectrum of the photoneutrons from P^{31} emitted at 90° with respect to a collimated bremsstrahlung beam of E_{max} = 30 Mev is studied by means of nuclear emulsions. In the neutron spectrum a high-energy tail and a wide peak around 5.5 Mev show that other processes besides evaporation occur in the neutron emission. The direct interaction may account for about 30% of the emitted neutrons. (auth)

13529 ON THE INTERACTIONS OF 25 Gev PROTONS IN NUCLEAR EMULSIONS. [PART] I. P. G. Bizzeti (Istituto Nazionale di Fisica Nucleare, Florence), A. M. Cartacci, M. G. Dagliana, M. Della Corte, L. Tocci, G. Boebel, G. Tomasini, and A. Marzari-Chiesa. Nuovo Cimento (10), 27: 6-13(Jan. 1, 1963). (In English)

Some results on 25 Bev proton interactions in nuclear emulsions are obtained. A total mean free path is found for elastic and nonelastic events of (33.6 ± 1.5) cm. If the beam contamination from electrons and μ mesons is taken into account (32.6 ± 1.4) cm is found. The distribution in n_h is given, and from an examination of it, it is found that the generally accepted hypothesis that all the stars with $n_h \leq 4$ are due to the interactions with light nuclei seems in disagreement with the results. The distribution in n_s for separated classes of n_h is given. The correlation $\bar{n}_s$-n_h does not show the discontinuity found by Friedlander at 9 Bev. (auth)

13530 LOWER EXCITED STATES OF $_{22}Ti^{50}$. G. Chilosi, P. Cuzzocrea, G. B. Vingiani, R. A. Ricci, and H. Morinaga (Istituto Nazionale di Fisica Nucleare, Naples and Università, Naples). Nuovo Cimento (10), 27: 86-92 (Jan. 1, 1963). (In English)

A detailed investigation of the decay of Sc^{50} (1.7 min) was undertaken by scintillation techniques. Sc^{50} was produced by (n,p) reactions with 14 Mev neutrons on metallic titanium foils. The level structure of the two-$f_{\frac{7}{2}}$ proton configuration in Ti^{50} was well established with the following sequence: 0 (0^+); 1,570 kev (2^+); 2,695 (4^+); 3,215 (6^+). A complete decay scheme of Sc^{50} is proposed, with β transitions to the

6^+ and 4^+ states in Ti^{50}. On this basis it is assumed that the spin of the Sc^{50} ground state is 5^+ as expected by the shell model; however the β-transition probabilities can be explained assuming a configuration mixing between $(f_{\frac{7}{2}})(p_{\frac{3}{2}})$ and $(f_{\frac{7}{2}})(f_{\frac{5}{2}})$ couplings. (auth)

13531 IMPACT PARAMETER APPROACH TO THE EXPERIMENTAL STUDY OF HIGH-ENERGY JETS. K. Imaeda and M. Kazuno (Inst. for Advanced Studies, Dublin). Nuovo Cimento (10), 27: 119-40(Jan. 1, 1963). (In English)

A method of inferring the impact parameter for individual jets is proposed. On this basis, the analysis is made for the inelasticity K, multiplicity n_s, momentum of interaction Δp, mass M_b, and γ-factor of fireball γ_b of 200 jets produced by single charged or neutral primaries of energy from 10^{11} to 10^{14} ev. The results are given for the dependence of these quantities on both γ_c and the impact parameter b. Also the characteristic features of the jet such as peripheral collisions and head-on collisions are defined in connection with the value of the impact parameter. And the K, Δp, n_s and γ_b are obtained as functions of both b and γ_c. The correlations among these quantities were found, i.e., for the peripheral collision $b/R_a \gtrsim 0.8$, the K, Δp, and n_s are small and γ_b is large which results in large anisotropy and for the closer collision $b/R_a \lesssim 0.8$, the K, Δp, and n_s are large and $\gamma_b \sim 1$, which results in small anisotropy i.e., nearly an isotropic distribution in c.m.s. of the colliding nucleons. (auth)

13532 ON THE INTERACTIONS OF 25 Gev PROTONS IN NUCLEAR EMULSION. [PART] II. A. Marzari-Chiesa (Istituto Nazionale di Fisica Nucleare, Turin), G. Rinaudo, S. Ciurlo, E. Picasso, and A. M. Cartacci. Nuovo Cimento (10), 27: 155-63(Jan. 1, 1963). (In English)

Interactions of 25 Bev protons with free or quasi-free nucleons are studied in two emulsion stacks. The results are compared with similar results obtained in a hydrogen bubble chamber with the aim of establishing to what extent emulsions can give reliable information on the elementary proton-nucleon processes. A good agreement is found between multiplicity, momentum, and angular distributions. The distribution of γ_c as expected from H bubble-chamber results has been calculated with the Monte-Carlo technique and compared with the experimental results in emulsion. (auth)

13533 EXPERIMENTAL RESULTS ON ORBITAL-ELECTRON CAPTURE. G. Manduchi and G. Zannoni (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 27: 251-6(Jan. 1, 1963). (In English)

A summary is presented of experimental results on electron-capture ratios of Mn^{51}, A^{37}, Cr^{51}, Fe^{55}, and Ge^{71}, obtained in a high-pressure, multiwire proportional counter. The experimental values show a small but consistent discrepancy of some ten percent with the theoretical results. (auth)

13534 THE PRODUCTION AND DECAY OF A $_{\Lambda}B^{12}$ HYPERFRAGMENT. M. J. Beniston and D. H. Davis (University Coll., London). Phil. Mag. (8), 7: 2119-22 (Dec. 1962).

A K^--p interaction in an emulsion produces a Σ^- hyperon and a π^+ meson. The Σ^- is captured at rest by a C^{12} nucleus, producing $_{\Lambda}B^{12} + n$. The hyperfragment undergoes the decay $_{\Lambda}B^{12} \rightarrow 3\alpha + \pi^-$. The kinematics of the production and decay yield a binding energy for the Λ hyperon in the hyperfragment of 11.2 ± 0.8 Mev. The techniques used in determining that the hyperfragment is $_{\Lambda}B^{12}$, and the criteria for discarding the possible $_{\Lambda}B^{13}$ identity, are outlined. (T.F.H.)

13535 SPALLATION OF OXYGEN BY PROTONS AT 20 TO 150 Mev. G. Albouy, J.-P. Cohen, M. Gusakow, N. Poffe, H. Sergolle, and L. Valentin (Faculté des Sciences, Orsay, France). Phys. Letters, 2: 306-7(Nov. 1962). (In French)

Excitation functions are given for the following proton reactions on O^{16} at proton energies of 20 to 150 Mev: $(p,pn)O^{15}$; $[(p,2p2n)$ and $(p,\alpha)\,N^{13}$; $[(p,3p3n)$ and $(p,pn\alpha)]C^{11}$; and $[(p,5p5n)$ and $(p,3p3n\alpha)$ and $(p,pn\alpha)]Be^7$. The shapes and amplitudes of these excitation functions are compared with those of C^{12} and F^{19}. (T.F.H.)

13536 THE APPLICATION OF THE OPTICAL MODEL TO THE NEUTRON INTERACTIONS OF Li^6 AND Li^7. R. Batchelor and J. H. Towle (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Phys. Letters, 2: 312-13(Nov. 1962). (In English)

Differential elastic and total cross sections were obtained for the interactions of neutrons with Li^6 and Li^7 at 1.5 to 7.5 Mev and at 14 Mev by observing the energy spectra of the secondary neutrons emitted. This investigation points out the extent to which the nonlocal potential optical model is capable of predicting these cross sections and the shapes of the angular distributions. The comparison shows that at energies around 14 Mev the optical model gives a good account of the neutron scattering, and below 14 Mev a reasonable qualitative account is given by the model. (H.D.R.)

13537 DISTORTED-WAVES ANALYSIS OF QUASI-ELASTIC (p,n) AND (He^3,t) REACTIONS. R. M. Drisko, R. H. Bassel, and G. R. Satchler (Oak Ridge National Lab., Tenn.). Phys. Letters, 2: 318-20(Nov. 1962). (In English)

Experimental evidence has shown that the (p,n) and (He^3,t) reactions on medium-weight nuclei excite relatively strongly a state in the residual nucleus that is the isobaric analog of the target ground-state. A distorted-wave Born approximation analysis was made for $V^{51}(p,n)$ at 12.1 Mev and $Fe^{56}(He^3,t)$ at 25 Mev. The resulting cross sections for transitions to excited states show this method to be a very good approximation and to have the advantage that Coulomb effects can be included easily; so the theory can be applied at relatively low energies. (H.D.R.)

13538 MAGNETIC FIELD DEPENDENCE OF Am^{243} α-γ ANGULAR CORRELATIONS. K. Siegbahn and F. Asaro (Univ. of California, Berkeley). Phys. Letters, 2: 323-5(Nov. 1962). (UCRL-10419) (In English)

The anisotropy of the Am^{243} α-γ angular correlation with α decay recoils traveling into vacuum or into Ag was investigated as a function of applied magnetic field. Experimental and theoretical values of the angular correlation and attenuation factors are compared for a vacuum environment. (H.D.R.)

13539 ANGULAR DISTRIBUTION AND BACKWARD SCATTERING OF 15 TO 22.7 Mev ALPHA PARTICLES BY C^{12}, N^{14} AND O^{16}. J. C. Jodogne, P. C. Macq, and J. Steyaert (Université, Louvain, Belg.). Phys. Letters, 2: 325-8(Nov. 1962). (In English)

The angular distributions in the reactions $C^{12}(\alpha,\alpha)$ and $O^{16}(\alpha,\alpha)$ were measured between 40 and 180° (cm) for 21.2, 21.8, 22.1, 22.4, and 22.7 Mev incident alpha particles. Also measured was the differential cross section at 176° c-m as a function of alpha energy. Results are presented for C^{12} and N^{14} from 15 to 22.7 Mev and for O^{16} from 14 to 22.7 Mev. (H.D.R.)

13540 DETERMINATION OF THE ϵ_K/β^+ RATIO AND ENDPOINT ENERGY OF INTERNAL BREMSSTRAHLUNG DUE TO THE ELECTRON CAPTURE PROCESS IN THE NON-UNIQUE SECOND FORBIDDEN DECAY OF Cl^{36}. D. Berenyi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Phys. Letters, 2: 332-4(Nov. 1962). (In English)

The $2^+ \rightarrow 0^+$ nonunique second forbidden transition decay of Cl^{36} into S^{36} was examined for the presence of positron emission. From scintillation γ-spectra obtained with a 50 μC-source and previous determinations of the rate of electron capture, the ϵ_K/β^+ ratio for the transition is calculated as $(7.5 \pm 3.0) \times 10^2$. The uncorrected experimental bremsstrahlung spectrum and the Jauch-diagram with corrections are shown. (H.D.R.)

13541 MÖSSBAUER EFFECT IN Kr^{83} TRAPPED IN A CLATHRATE COMPOUND. Y. Hazoni, P. Hillman, M. Pasternak, and S. Ruby (Israel Atomic Energy Commission, Rehovoth and Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 2: 337-9(Nov. 1962). (In English)

The γ spectra of Kr^{83} in clathrate are shown at 107°K for a Mössbauer source vibrating (on) and fixed (off). Both source and absorber were arranged so their temperature could be regulated together, and the resulting on-off 9.3 kev γ-ray differences are given as a function of temperature. The Mössbauer velocity spectrum for the 9.3 kev γ with both clathrate source and absorber at 102°K is also shown. (H.D.R.)

13542 10 Mev PROTON REACTION CROSS SECTIONS. G. Igo and B. D. Wilkens (Univ. of California, Berkeley). Phys. Letters, 2: 342-4(Nov. 1962). (UCRL-10480) (In English)

Proton nonelastic cross sections were obtained near 10 Mev from Be, C, Al, Ti, Mo, Zr, Fe, Ni, Zn, Cu, V, Rh, Nb, Ag, Sn, Ta, Th, Au, and Pb. The most significant features of the data are the appearance of a minimum in the vicinity of nuclei with Z = 28 protons, an anomalously low cross section for carbon, and a systematic deviation from optical model predictions for heavier elements. Proton reaction cross sections from both volume and surface absorption predictions are compared to experimental values. (H.D.R.)

13543 LIFETIMES OF LOWEST LEVELS IN NUCLEI La^{139} AND Pm^{145} AND NATURE OF l-FORBIDDEN TRANSITIONS. E. Ye. Berlovich, G. M. Bukat, Yu. K. Gusev, V. V. Il'in, V. V. Nikitin, and M. K. Nikitin (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Letters, 2: 344-7 (Nov. 1962). (In English)

The half lives of the 165-kev level in La^{139} and the 61.3-kev level in Pm^{145} were determined as $(1.47 \pm 0.05) \times 10^{-9}$ and $(2.7 \pm 0.1) \times 10^{-9}$ seconds, respectively. Matrix elements for similar l-forbidden proton M1-transitions in neighboring nuclei are compared with the data for La^{139} and Pm^{145}. The observed probabilities of l-forbidden proton transitions in the region of nuclei considered can be explained in terms of configuration mixing only for nuclei not very far from the shells N = 82 and Z = 50. As Z and N increase, and the deformation region is approached, such a method of description becomes invalid. (H.D.R.)

13544 TRANSVERSE POLARISATION OF CONVERSION ELECTRONS FOLLOWING BETA DECAY OF Hg^{203}. S. K. Bhattacherjee, E. Giberman, H. J. Lipkin, and A. Nir (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 2: 347-9(Nov. 1962). (In English)

The transverse polarization ($\rho_\perp$) of the K-conversion electrons following nonunique first-forbidden beta decay in Hg^{203} was measured as $+0.37 \pm 0.06$. Analysis of the results indicates that the spin assignment $I_1 = 5/2$ is eliminated for Hg^{203}, and that $I_1 = 3/2$ is favored with $I_1 = 1/2$ also possible. The positive sign of ρ indicates the conversion electron spins are pointed toward the direction of emission of the beta particle. (H.D.R.)

13545 PREFERENTIAL POLAR EMISSION IN THE ALPHA DECAY OF DEFORMED Cf^{249} AND E^{253}. Q. O. Navarro, J. O. Rasmussen, and D. A. Shirley (Univ. of California, Berkeley). Phys. Letters, 2: 353-5(Nov. 1962). (UCRL-9960(Rev.)) (In English)

Hill and Wheeler predicted that prolately deformed alpha-emitting nuclei should exhibit enhanced emission from the polar regions because of the lower Coulomb barrier in these regions. Described are orientation experiments on Cf^{249} and Es^{253} that provide independent confirmation of their predictions. Specifically, the L = 2 component in the main alpha group is appreciable and is in phase ($\delta > 0$) with the dominant L = 0 wave. (H.D.R.)

13546 KINEMATIC EFFECT IN FISSION INDUCED BY 156 Mev PROTONS IN THE NUCLEI OF U, Bi, AND Au. L. Kowalski, C. Stephan, H. Langevin-Joliot, and P. Radvanyi (Faculté des Sciences, Orsay, France). Phys. Letters, 2: 356-7(Nov. 1962). (In French)

Targets of Au, Bi, and U are subjected to bombardment by 156-Mev protons. Two detectors are placed in coincidence in the reaction plane, one at an angle of 90° with the incident protons and the other at an angle of $-(90° - \phi)$ with the incident protons. Coincidences produced by fission fragments striking the counters are counted as a function of ϕ. The results for Au and Bi, for which the maximum coincidence rates occur for $\phi \cong 7$ or 8°, indicate that the fission occurs through compound nucleus formation. It is concluded that the fission of U ($\phi_{max} \cong 4°$) probably takes place by a direct process. (T.F.H.)

13547 STATIC QUADRUPOLE INTERACTION IN Ta^{181}. R. W. Sommerfeldt and L. Schecter (Oregon State Univ., Corvallis). Phys. Letters, 3: 5-6(Nov. 15, 1962). (In English)

A static quadrupole interaction in polycrystalline hafnium metal was observed by a study of the delayed 133–482 kev gamma-gamma angular correlation in Ta^{181}. The quadrupole coupling determined from the observed time dependence of the anisotropy is 333 ± 15 Mc/sec. (H.D.R.)

13548 DOUBLE INTERNAL CONVERSION. G. Baeckstroem, J. Lindskog, and J.-O. Lindstroem (Univ of Uppsala). Phys. Letters, 3: 23-4(Nov. 15, 1962). (In English)

A possible mode of de-excitation of nuclei is the sharing of the transition energy between two conversion electrons, each possessing a continuous energy distribution. A direct observation of this double conversion process has been made for the 192-kev isomeric transition in In^{114}. The effect observed is concluded to be due to a nuclear two-quantum process with a rate of 3×10^{-4} two-step transitions per direct transition. (H.D.R.)

13549 COULOMB DISINTEGRATION OF μ-MESONIC ATOMS. Y. N. Kim (Univ. of Alberta, Edmonton). Phys. Letters, 3: 33-5(Nov. 5, 1962). (In English)

The possibility of the electric break-up of mesic atoms in the Coulomb field due to the nuclei of neighboring atoms is investigated by calculating the probabilities of Coulomb disintegration of μ-mesic Li atoms at 5-kev incident energy when the muons are in (n = 4, l = 3) and (n = 3, l = 2) states, respectively. The Coulomb disintegration probability is found to vary sensitively as a function of the incident energy. (H.D.R.)

13550 DECAY SCHEMES OF In^{116} (13 sec): A 0^+ LEVEL IN Sn^{116}. P. Fettweis and J. Vervier (Centre d'Etude de l'Energie Nucléaire, Mol, Belgium). Phys. Letters, 3: 36-9(Nov. 15, 1962). (In English)

The γ spectrum associated with the decay of ground state In^{116g} was investigated to determine if excited states of Sn^{116} can be reached from In^{116g}. The half life associated with intense lines observed at 0.45 and 1.27 Mev was measured to be 13 seconds, and the lines are associated with the decay of In^{116g}. The decay scheme is concluded to go to the 0^+ ground state of Sn^{116}, to the 2^+ first excited state at 1.27 Mev, and to a level at 1.72 Mev. The various decay schemes and energies are discussed, and the ratio of energies of the first 0^+ and 2^+ levels in even nuclei is plotted against mass number. (H.D.R.)

13551 CROSS SECTION RATIOS FOR THE PRODUCTION OF THE THREE ISOMERS OF In^{116} BY THERMAL NEUTRON CAPTURE. P. Fettweis (Centre d'Etude de l'Energie Nucléaire, Mol, Belgium). Phys. Letters, 3: 40-1(Nov. 15, 1962). (In English)

Thermal neutron capture in In^{115} gives rise to three isomers of In^{116}. The ratios of the partial cross sections for the formation of these isomers to the total cross section were calculated for different choices of the capture gamma multiplicity, a level density parameter, and for the two "a priori" possible spins (4 and 5) of the capturing state. The calculated values are discussed and compared with experimental results. (H.D.R.)

13552 E2 INTERNAL CONVERSION COEFFICIENTS FOR ROTATIONAL TRANSITIONS. D. C. Lu (Yale Univ., New Haven) and R. S. Dingus. Phys. Letters, 3: 44-5 (Nov. 15, 1962). (In English)

The total and K-shell internal conversion coefficients of Sm^{152}, Gd^{154}, and Dy^{160} were measured directly using a high-accuracy coincidence-sum method. In all three cases, there is agreement between the theoretical (α(th)) and the experimental (α(exp)) values of the total E2 conversion coefficients within the accuracy of the theoretical computations. No correlation was found between α(exp)/α(th) and the neutron number to proton number ratio. (H.D.R.)

13553 THE g-FACTOR OF THE 2.083-Mev 4^+ STATE OF Ce^{140}. R. M. Levy and D. A. Shirley (Univ. of California, Berkeley). Phys. Letters, 3: 46-7(Nov. 15, 1962). (UCRL-10454). (In English)

The g-factor of the 2.083-Mev 4^+ level in Ce^{140}, populated in the decay of La^{140}, was determined by using the correlation of the 329-487-kev cascade. Three measurements were made that yielded an average g-factor of g(2.083) = +1.83 ± 0.16. The results indicate that the 2.083-Mev level has $d^{5/2}$ proton subshell character rather than the expected $g^{7/2}$ character. (H.D.R.)

13554 TOTAL REACTION CROSS SECTIONS FOR 22.4 Mev DEUTERONS. B. Wilkins and G. Igo (Univ. of California, Berkeley). Phys. Letters, 3: 48-9(Nov. 15, 1962). (UCRL-10500). (In English)

The reaction cross sections for 22.4-Mev deuterons were measured for a number of elements. The reaction cross sections are apparently not enhanced by the large magnitude of the breakup cross sections. A comparison of the deuteron reaction cross sections with 40-Mev alpha particle reaction cross sections shows them to be identical for almost all elements investigated. The final results $\sigma_R - \sigma_{CE}$, where σ_R is the total reaction cross section and σ_{CE} represents compound elastic scattering, are tabulated and discussed. (H.D.R.)

13555 GENERALIZED DALITZ DIAGRAM IN LOW-ENERGY NUCLEAR PHYSICS. D. Dehnhard, D. Kamke, and P. Kramer (Universität Marburg, Ger.). Phys. Letters, 3: 52-5(Nov. 15, 1962). (In German)

The characteristics of nuclear reactions of the type $A + a \rightarrow C^* \rightarrow b_1 + b_2 + b_3$ can be surveyed by plotting the energy angular correlations on a generalized Dalitz diagram. The generalized Dalitz diagram consists of a triangle whose sides have lengths proportional to the masses b_1, b_2, and b_3. The construction of the diagram, the formula for plotting the coincidence measurements, and the application of the results are described for the reaction $B^{11} + p \rightarrow C^{12*} \rightarrow 3\alpha$. (T.F.H.)

13556 LIFETIME OF THE 26.8 kev STATE OF I^{129}. H. De Waard, M. H. Garrell, and D. Hafemeister (Univ. of Illinois, Urbana). Phys. Letters, 3: 59(Dec. 1, 1962). (In English)

The lifetime of the 26.8-kev level in I^{129} was measured as 26.8 ± 1.5 nsec from the delay distribution of the 26.8-kev γ rays that follow excitation of the level by β particles of maximum energy 1.45 Mev. (H.D.R.)

13557 ANOMALIES OF THE PARTIAL WIDTHS OBSERVED IN CERTAIN NEUTRON RESONANCES. J. Julien, C. Corge, V. D. Huynh, J. Morgenstern, and F. Netter (Centre d'Etudes Nucleaires, Saclay, France). Phys. Letters, 3: 67-9(Dec. 1, 1962). (In French)

Anomalous neutron and gamma widths in the reactions of neutrons on Se^{77}, Y^{89} and Pt^{195} are analyzed. The energy levels of Se^{78}, Y^{90}, and Pt^{195} are discussed. (T.F.H.)

13558 POSSIBLE EVIDENCE FOR NUCLEAR E1 OVERTONES IN O^{16}. G. R. Bishop and D. B. Isabelle (Faculté des Sciences, Orsay, France). Phys. Letters, 3: 74-5(Dec. 1, 1962). (In English)

The inelastic cross section for electron scattering by O^{16} was observed to concentrate into two peaks at excitation energies of 44.5 and 49 Mev with widths of 2-3 Mev. These data are analyzed by comparison with the form factors expected for E0, E1, and E2 transitions, and E1 and E2 transition probabilities are calculated. It is concluded that the observed inelastic scattering is compatible with an E1 transition since the excitation energy corresponds to the expected value and the integrated cross section does not violate the E1 sum rule. (H.D.R.)

13559 PENETRATION EFFECTS IN THE INTERNAL CONVERSION OF THE M1 TRANSITIONS BETWEEN ROTATIONAL STATES. T. Novakov (Inst. of Nuclear Sciences, Belgrade and Univ. of Belgrade). Phys. Letters, 3: 82-4(Dec. 1, 1962). (In English)

Experiments were performed to demonstrate the anomalous conversion properties of the M1 transitions between rotational states in odd-mass nuclei. The internal conversion coefficient was determined for the K and L_1 shells from the 94-kev transition in Ho^{165}. The L subshell conversion ratios were determined for the 94-kev transition in Ho^{165}, the 114-kev transition in Ln^{175}, and the 134-kev transition in Re^{187} and compared to previous results for transitions in Eu^{153}, Cs^{133}, and Tl^{203}. The results give a rough indication of a possible dependence of the penetration effect on the nuclear deformation. (H.D.R.)

13560 THE NUCLEAR RESONANT SCATTERING OF NEUTRON CAPTURE GAMMA-RAYS. G. Ben-David (Davis) and B. Huebschmann (Israel Atomic Energy Commission, [Rehovoth]). Phys. Letters, 3: 87-9(Dec. 1, 1962). (In English)

The mono-energetic gamma rays produced in the capture of thermal neutrons were used in an examination of the nu-

clear elastic scattering of a number of natural elements. Using different γ sources a total of 11 clear examples of resonant scattering were observed. A typical spectrum showing resonant scattering is shown, and the total elastic scattering cross section is tabulated for each of the 11 cases. It is concluded that the probability of finding a chance resonance condition between a discrete-energy capture gamma and a random nuclear energy level is of the order of 1 or 2% per investigated element in the energy region 6 to 10 Mev. (H.D.R.)

13561 PHOTO-ALPHA REACTION IN Al^{27}. C. Becchi, L. Meneghetti, and S. Vitale (Università, Genoa). Phys. Letters, 3: 89-92(Dec. 1, 1962). (In English)

Measurements were made of the forward and backward spectra of photo-alphas produced by 30-Mev bremsstrahlung incident on an Al target. The forward-backward asymmetry spectrum is shown and its irregular behavior is discussed. (H.D.R.)

13562 THE D.W.B.A. FOR $Cr^{52}(d,p)Cr^{53}$ REACTION WITH MEASURED OPTICAL MODEL PARAMETERS. P. T. Andrews, R. W. Clifft, L. L. Green, and J. F. Sharpey-Schafer (Univ. of Liverpool). Phys. Letters, 3: 97-9(Dec. 1, 1962). (In English)

The angular distributions of protons from $Cr^{52}(d,p)$ reactions were studied for various states of Cr^{53} at bombarding energies of 7 and 8 Mev. The angular distributions of deuterons elastically scattered from Cr^{52} were measured at 7 and 8 Mev, and the proton elastic scattering from Cr^{53} was studied at 10 and 11 Mev. The elastic scattering results are shown with curves from an optical model fit. The $Cr^{52}(d,p)$ distorted-wave Born approximation (D.W.B.A.) curves calculated with two types of deuteron solution are compared to measured optical model parameters. (H.D.R.)

13563 RELATIVE E1 TRANSITION PROBABILITIES IN STRONGLY DEFORMED ODD NUCLEI. Hiroshi Yoshida and Ching Liang Lin (Tokyo Univ. of Education). Phys. Letters, 3: 107-8(Dec. 1, 1962). (In English)

The intensities of relative E1 transitions going from a given state to various rotational states in the strongly deformed odd nuclei Lu^{175}, Hf^{177}, and Yb^{173} show a large discrepancy with predictions by Alaga's rules. This discrepancy is shown to be removed on the basis of the Nilsson model by considering the rotation particle coupling. Energy spectra of the nuclei and ratios of the intensities of the γ transitions are presented and discussed. (H.D.R.)

13564 THE SPINS AND PARITIES OF THE 1.35 AND 1.46 Mev LEVELS OF F^{19}. J. D. Prentice, N. W. Gebbie, and H. S. Caplan (Univ. of Toronto). Phys. Letters, 3: 201-3(Jan. 15, 1963). (In English)

The spins and parities of the fourth and fifth energy levels of F^{19} were experimentally determined. The state at 1.35 Mev has spin and parity $5/2^-$ and the 1.46 Mev state has spin and parity $3/2^-$. These results were obtained as part of a more complete study of the γ rays emitted in the de-excitation of the levels 1.35, 1.46, and 1.56 Mev. The multipole mixing ratios for some of the γ rays were measured. (C.E.S.)

13565 E3 COULOMB EXCITATION OF F^{19}. A. E. Litherland, M. A. Clark, and C. Broude (National Research Council of Canada, Chalk River, Ont.). Phys. Letters, 3: 204-6(Jan. 15, 1963). (In English)

The Coulomb excitation of the five levels in F^{19} below 1.6 Mev was studied by bombarding thick targets of aluminum, silicon, nickel, and germanium with F^{19} ions. Ion currents of 2 to 0.1 μ amp were used in the energy range from 18-35 Mev. The E3 de-excitation of the 1.35 Mev level was several times larger than the expected theoretical value. Yield curves and angular correlations of the de-excitation γ rays were studied. (C.E.S.)

13566 LARGE SECOND ORDER EFFECTS IN THE COULOMB EXCITATION OF F^{19}. D. Beder (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Letters, 3: 206-9(Jan. 15, 1963). (In English)

The possibility that large contributions to the observed F^{19} transition rates might arise from second order Coulomb excitation stimulated this investigation. Employing computer calculations of the second order Coulomb excitation cross section formulas previously derived, it was shown that in heavy ion collisions such as were involved in F^{19} studies, second order effects may be comparable in magnitude to first order effects and through their interference with first order ones, may permit measurement of transition probabilities sometimes unattainable by other means. (C.E.S.)

13567 ON THE NEGATIVE PARITY STATES OF O^{17}, O^{18}, AND F^{19}. M. Harvey (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Letters, 3: 209-11(Jan. 15, 1963). (In English)

Theoretical explanation of the negative parity states in the (2s,1d) shell and their apparent collective properties were discussed. The initial results of calculations on the negative parity states of O^{17}, O^{18}, and F^{19} were presented. The work was based on a shell model that explained these properties. (C.E.S.)

13568 ISOBARIC SPIN PURITY IN HEAVY NUCLEI. L. Lovitch and S. Rosati (Instituto Nazionale di Fisica Nucleare, Pisa, Italy). Phys. Letters, 3: 222-3(Jan. 15, 1963). (In English)

A charge dependent nuclear potential was examined to determine to what extent it modifies previous results. Earlier experiments found that on the stability line there is very little mixing with states of different isobaric spin and that the purity of ground state isobaric spin increases with mass number. (C.E.S.)

13569 MEASUREMENT OF THE $\mu^- + He^3 \rightarrow H^3 + N$ REACTION RATE: FINAL RESULTS. I. V. Falomkin, A. I. Filippov, M. M. Kulyukin, B. Pontecorvo, Yu. A. Scherbakov, R. M. Sulyaev, V. M. Tsupko-Sitnikov, and O. A. Zaimidoroga (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 3: 229-31(Jan. 15, 1963). (In English)

The final results of an He^3 diffusion chamber experiment were given, based on 200 events of the reaction $\mu^- + He^3 \rightarrow H^3 + \nu$. (C.E.S.)

13570 BETA-DECAY MATRIX ELEMENTS IN THE DECAY OF Pm^{148}. C. V. K. Baba, G. T. Ewan, and J. F. Suarez (Universitet, Copenhagen). Phys. Letters, 3: 232-4 (Jan. 15, 1963). (In English)

The measurements were made using a source of Pm^{148} that was chemically separated by an ion exchange column and the activity of mass number 148 separated in an electromagnetic separation onto an Al foil of thickness 150 $\mu g/cm^2$. The beta spectrum was studied using the Copenhagen six-gap orange spectrometer, operated at a momentum resolution of 2%. At each energy the pulse height distribution of the focussed electron was recorded as a precaution against detection of scattered electrons. (C.E.S.)

13571 INTERPRETATION OF QUASI-ELASTIC SCATTERING OF 11-19 Mev MONOCHROMATIC PHOTONS BY HOLMIUM USING ZERO-POINT VIBRATIONS IN THE HYDRODYNAMIC MODEL. P. A. Tipler, P. Axel, N. Stein, and D. C. Sutton (Univ. of Illinois, Urbana). Phys. Rev., 129: 2096-2112(Mar. 1, 1963).

A bremsstrahlung monochromator with an energy resolution of 0.6% was used to measure the 135° quasi-elastic scattering of photons by Ho^{165} at 48 energies between 10.92 and 19.06 Mev. No very fine structure was observed but the gross splitting of the giant dipole resonance of this deformed nucleus into two peaks was clearly resolved. The 135° differential scattering cross section has maxima at 12.49 Mev (0.35 mb/sr) and 16.50 Mev (0.45 mb/sr); a minimum occurs at 13.50 Mev (0.28 mb/sr). The observed energy dependence confirms the existence of tensor polarizability (i.e., the absorption cross section depends on the relative orientation of the nuclear spin and the photon polarization). The combination of the observed scattering and photoabsorption results can be used to test photonuclear models; the existing data suggest that it may be necessary to refine the hydrodynamic model by including zero-point vibrations. The absolute magnitude of the scattering implies that the previously reported energy-integrated absorption cross section should be reduced by 21%; this reduces the integrated sum in the giant resonance to 1.07 ± 0.16 times the sum rule prediction without exchange forces. (auth)

13572 NUCLEAR MAGNETIC MOMENTS OF W^{183}, Os^{187}, AND Fe^{57}. Richard R. Chasman (Argonne National Lab., Ill.). Phys. Rev., 129: 2113-16(Mar. 1, 1963). (TID-16262)

By making use of a single-particle potential which does not have axial symmetry, the anomalously low magnetic moments of W^{183}, Os^{187}, and Fe^{57} are accounted for. The low-energy spectrum of W^{183} and observed electromagnetic transitions are treated in detail. Good agreement is found between the calculations and the experimental observations. (auth)

13573 ANOMALOUS BETA SPECTRUM OF In^{114} ($1^+ \rightarrow 0^+$). G. P. Bhalla (Westinghouse Electric Corp., Pittsburgh). Phys. Rev., 129: 2130-2(Mar. 1, 1963).

The experimental beta-shape factor of In^{114} ($1^+ \rightarrow 0^+$) as reported to be represented by (1 + b/W) is analyzed. A reasonable fit is found to the experimental shape factor of the Langer group by considering the contribution of the second-order effects within the framework of the V–A theory. The less anomalous beta-shape factor due to Daniel and Panussi can also be explained. The effects arising from a consideration of the finite nuclear size and the finite de Broglie wavelength were included in the calculations. (auth)

13574 FURTHER STUDIES OF THE PROMPT NEUTRONS FROM THE SPONTANEOUS FISSION OF Cf^{252}. Harry R. Bowman, J. C. D. Milton, Stanley G. Thompson, and Wladslaw J. Swiatecki (Univ. of California, Berkeley). Phys. Rev., 129: 2133-47(Mar. 1, 1963). (UCRL-10139; UCRL-10139(Rev.))

Results of neutron and fission fragment time-of-flight measurements on Cf^{252} are presented in detail. The energy spectra and angular distributions of neutrons emitted by pairs of fragments of different degrees of asymmetry and different kinetic energies, as recorded in the laboratory system, have been analyzed for consistency with the hypothesis of isotropic emission from fully accelerated fission fragments. The center-of-mass energy spectra of the neutrons, when these are assumed to be emitted isotropically from moving fragments, have been found to be representable, within fairly narrow limits, by a standard shape. Given this shape, the neutron distribution may be specified by the number of neutrons ν emitted by a fragment and the average energy $\bar{\eta}$. The two quantities ν and $\bar{\eta}$ have been analyzed as functions of the mass number A of a fragment and the kinetic energy E_K as a fragment pair, and the detailed results are presented in a series of graphs. The variation of ν with A shows the "saw-tooth" dependence found in earlier experiments, which may be studied in greater detail on the basis of our results. In contrast, the dependence of $\bar{\eta}$ on A does not show a discontinuity in the region of symmetrical mass splits, the values of $\bar{\eta}$ being always approximately equal for the two members of a fragment pair. The results of a few simple calculations are presented along with the data, but no systematic attempt is made to interpret the neutron distributions. (auth)

13575 LIFETIME DETERMINATION OF THE 2+ AND 4+ ROTATIONAL LEVELS IN Gd^{154} AND THE EFFECT OF ROTATION-VIBRATION INTERACTION. J. Burde, M. Rakavy, and G. Rakavy (Hebrew Univ., Jerusalem). Phys. Rev., 129: 2147-51(Mar. 1, 1963).

The lifetimes of the 2^+ and 4^+ rotational levels of Gd^{154} were determined by coincidence measurements between the beta spectrum of Eu^{154} and the conversion lines deexciting the levels under investigation, utilizing a double-lens coincidence spectrometer. The measurements were carried out using the self-comparison method and a time-to-amplitude converter. The mean lifetimes of the 371- and the 123-kev levels were found to be $(5.6 \pm 0.7) \times 10^{-11}$ sec and $(1.67 \pm 0.07) \times 10^{-9}$ sec, respectively. The measured ratio for the reduced transition probabilities, $B(E2; 4^+ \rightarrow 2^+)/B(E2; 2^+ \rightarrow 0^+) = 1.77 \pm 0.25$, deviates from the value 1.43 predicted by the strict rotational model. The effect of rotation-vibration interaction on the transition probability ratios within a rotational band is discussed. These ratios are related uniquely to the distortion of the energy spacings. In the case of the ground-state band of Gd^{154}, theory thus predicts $B(E2; 4^+ \rightarrow 2^+)/B(E2; 2^+ \rightarrow 0^+) = 1.62$ in agreement with experiment. (auth)

13576 INVESTIGATION OF HIGH-SPIN STATES IN Er^{166}. J. E. Cline and C. W. Reich (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 129: 2152-64(Mar. 1, 1963).

The decay of the long-lived isomer of Ho^{166} has been studied using gamma-ray scintillation spectrometers and silicon-diode detectors. The results of gamma-gamma coincidence experiments, together with least-squares analysis of the gamma-ray singles spectra, establish the presence of twenty-seven gamma-ray transitions in the decay of this isomer. The conversion-electron spectra provide relative intensities for several of the weak transitions and provided an upper limit for the endpoint energy of the main beta transition from Ho^{166}. The data are consistent with the existence of levels whose energies (in kev) and assignments are 80 (2+), 265 (4+), 545 (6+), 787 (2+), 861 (3+), 910 (8+), 957 (4+), 1074 (5+), 1220 (6+), 1374 (7+), 1680 (5−), 1785 (6−), and 1840 (6−). The data indicate that the energy of the most intense beta transition from the long-lived Ho^{166} state must lie between ≈55 and ≈65 kev. Several possible nucleon configurations for the negative-parity states in Er^{166} observed in the decay of this activity are presented and discussed. A description of the observed positive-parity states in terms of an asymmetric-rotator model is given. The agreement between the energies and relative transition probabilities calculated using this model and those observed experimentally is excellent. Formulas for reduced transition probabilities for gamma-ray transitions between states having spins of 6, 7, and 8 are presented. (auth)

13577 INTRINSIC EXCITATION OF EVEN-EVEN NUCLEI. Tatuya Sasakawa (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 129: 2165-73(Mar. 1, 1963).

Intrinsic excitations of the rotational levels of even-even nuclei and the intrinsic structure of the wave functions are investigated. The rotational levels of negative parity are treated on the same basis as the levels of positive parity. The experimental energy levels are analyzed in order to obtain information about the intrinsic excitation in excited states of even-even nuclei. (auth)

13578 LIFETIME OF THE Be^{10} 3.37-Mev LEVEL. I. EXPERIMENT. E. K. Warburton, D. E. Alburger, and D. H. Wilkinson (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2180-90(Mar. 1, 1963). (BNL-6410)

Collective effects in E2 transitions are found even in light nuclei. Knowledge of this phenomenon is extended by measuring the lifetime of the 2^+ first excited state of Be^{10} at 3.37 Mev. To do this two new variants of the Doppler-shift attenuation method were used. The Be^{10} was produced by the $Be^9(d,p)Be^{10}$ reaction and the recoiling Be^{10} was slowed down in beryllium or in beryllium-copper. A mean lifetime of $(1.4 \pm 0.3) \times 10^{-13}$ sec was obtained. The analysis of Doppler-shift measurements is given at length. (auth)

13579 LIFETIME OF THE Be^{10} 3.37-Mev LEVEL. II. ANALYSIS. E. K. Warburton (Brookhaven National Lab., Upton, N. Y.), D. E. Alburger, D. H. Wilkinson, and J. M. Soper. Phys. Rev., 129: 2191-4(Mar. 1, 1963). (BNL-6411)

The E2 lifetime of $(1.4 \pm 0.3) \times 10^{-13}$ sec for the first excited state of Be^{10} at 3.37 Mev is discussed from the viewpoint of the independent-particle model. This transition is particularly suitable for analysis in terms of collective effects because the prediction of the pure independent-particle model (no mixing of major shells) is almost independent of the value of the intermediate coupling parameter a/K in the range 3–5 that is acceptable from other points of view. In the parameterization of the collective effects that consists of maintaining the independent-particle model wave functions but introducing an effective charge factor x such that the proton charge becomes (1 + x)e and the neutron charge xe, we find $x = 0.5 \pm 0.2$. A satisfactory account in terms of the pure independent-particle model is excluded, and powerful collective effects are demanded even at A = 10. So large a value of x may throw some doubt on the use of simple independent-particle model wave functions as a realistic starting point for the discussion of 1p-shell nuclei. A major uncertainty in the analysis is the effective mean square nuclear radius and some discussion is given of this. The speed of the E2 transition from the first excited state of B^{10} is discussed in the same spirit. Consistency with the results on Be^{10} is found only for a/K = 4–5, x = 0.4–0.7, and a rather large nuclear radius. (auth)

13580 NOTE ON THE DECAY OF Sb^{122m}. E. der Mateosian and M. L. Sehgal (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2195-7(Mar. 1, 1963). (BNL-6377)

Recent information has helped remove contradictions in the assigned properties of the isomeric transition in Sb^{122}. The association of a 530-μsec half-life with the second excited state in Sb^{122} is confirmed and yields an E2 transition which is delayed by a factor of ~420. A newly reported third transition in Sb^{122m} is confirmed and shown to precede the 530-μsec state. The energy of this transition was measured and found to be 26 ± 1 kev. The decay scheme and the hindered transitions are discussed and compared with theory. (auth)

13581 10-Mev PROTON REACTION CROSS SECTIONS FOR SEVERAL ELEMENTS. Bruce D. Wilkins and George Igo (Univ. of California, Berkeley). Phys. Rev., 129: 2198-2206(Mar. 1, 1963).

Proton nonelastic cross sections at 10 Mev from Be, C, Al, Ti, Mo, Zr, Fe, Ni, Zn, Cu, V, Rh, Nb, Ag, Sn, Ta, Th, Au, and Pb were obtained. The most significant feature of the data is the appearance of two strong minima in the elements lighter than Cu. The data are compared with optical-model predictions. These calculations predict the right order for the reaction cross section when a surface absorption potential that fits existing elastic-scattering data is used. However, on the basis of the data, a volume absorption potential of the Woods-Saxon shape cannot be excluded. The data are compared with other measurements of nonelastic cross sections for 10-Mev protons. (auth)

13582 GAMMA RAYS FROM THE $Be^9(\alpha,n_1)C^{12}$ REACTION. J. B. Seaborn, G. E. Mitchell, N. R. Fletcher, and R. H. Davis (Florida State Univ., Tallahassee). Phys. Rev., 129: 2217-19(Mar. 1, 1963).

The excitation function of the 4.43-Mev gamma ray from the $Be^9(\alpha,n_1\gamma_{4.43})C^{12}$ reaction has been studied and angular distributions have been measured at 13 alpha-particle energies from 3.6 to 7.6 Mev in an effort to determine compound nucleus nature of the $Be^9 + \alpha$ system. Many broad resonances are found in the energy region studied. (auth)

13583 ELECTRON SHAKE OFF FOLLOWING THE β^- DECAY OF He^6. T. A. Carlson, Frances Pleasonton, and C. H. Johnson (Oak Ridge National Lab., Tenn.). Phys. Rev., 129: 2220-6(Mar. 1, 1963).

The charge spectrum of the Li^6 ions formed following the β^- decay of He^6 has been measured as a function of their recoil energy by means of a specially designed mass spectrometer. The analysis is as follows: charge 1 (89.6 ± 0.2)%; charge 2 (10.4 ± 0.2)% of which (0.31 ± 0.05)% is dependent on recoil energy; charge 3 (0.042 ± 0.007)% of which (0.024 ± 0.009)% is dependent on recoil energy. Comparison with theory shows that electron shake off results primarily from excitation by the sudden nonadiabatic change in nuclear charge. An expression is given for describing the simultaneous excitations from the sudden changes in nuclear charge and velocity. (auth)

13584 DECAY OF Sc^{48}. Manny Hillman (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2227-30 (Mar. 1, 1963). (BNL-6456)

A previously unreported gamma ray of approximately 175 kev and 7% abundance was found in the decay of Sc^{48}. This necessitates a revision of the decay scheme to include a second beta group with an end-point energy of approximately 475 kev. The presence of the new gamma and second beta group was confirmed by means of gamma-gamma and beta-gamma coincidence counting techniques. (auth)

13585 ELASTIC SCATTERING OF ALPHA PARTICLES FROM HELIUM. T. A. Tombrello and L. S. Senhouse (California Inst. of Tech., Pasadena). Phys. Rev., 129: 2252-8(Mar. 1, 1963).

The scattering of alpha particles from He^4 has been studied for laboratory energies between 3.8 and 12 Mev. Ten angular distributions have been measured over this range of energies as well as excitation curves at the center-of-mass angles 30.6°, 40°, 54.8°, 70.2°, and 90°. A phase-shift analysis of these data has been made and is compared to previously published results. (auth)

13586 THE $^{16}O(p,p')$ REACTION AT 150 Mev. D. J. Rowe, A. B. Clegg, G. L. Salmon, and P. S. Fisher (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 80: 1205-17 (Dec. 1962).

Measurements are presented of the cross sections for the separate production of the 6.06, 6.14, 6.92 Mev states of O^{16} in the $O^{16}(p,p')$ reaction induced by 150-Mev protons. Energy resolution adequate to observe the production of these states separately is obtained by observing coincidences between their de-excitation gamma radiation and the outgoing protons. Angular correlations between the gamma rays and the protons are also measured. The results are discussed to show the information they provide about the O^{16} nucleus. Some measurements of the $O^{16}(p,p\alpha)$ reaction made at the same time are also presented. (auth)

13587 NEUTRONS EMITTED IN THE $^{9}Be(d,n)^{10}B$ REACTION AT A DEUTERON ENERGY OF 80 kev. R. A. Coombe and J. Walker (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 80: 1218-24(Dec. 1962).

A diffusion cloud chamber has been used to examine the neutrons from the $Be^{9}(d,n)B^{10}$ reaction at a deuteron energy of 80 kev. The well-known levels have been verified, and evidence has been obtained in support of the controversial level at approximately 2.9 Mev. There is slight indication that this level may be composed of two levels with energies of 2.7 and 3.1 Mev. (auth)

13588 POSITRON-HYDROGEN SCATTERING. A. Temkin (Goddard Space Flight Center, Greenbelt, Md.). Proc. Phys. Soc. (London), 80: 1277-89(Dec. 1962).

The non-adiabatic theory of electron-hydrogen scattering is applied to the s-wave scattering of positrons by atomic hydrogen. The zero-order problem is considerably more difficult than the corresponding problem for electron-hydrogen scattering. Assuming that the most extensive of Rotenberg's calculations relating strictly to the zero-order problem is an adequate approximation of that problem, then calculation supports the conclusion that his final phase shifts are more correct than those of Schwartz. The non-adiabatic theory is also developed for higher partial-wave scattering. The portion of the coupled set of equations which gives the major contribution to the phase shifts can readily be isolated. A first approximation of the truncated p-wave equations is obtained; the corresponding phase shifts are found to be positive, but much smaller than those of Bransden. (auth)

13589 NUCLEAR FORCES AND BOSONS. THE SAKATA MODEL AND ONE-BOSON-EXCHANGE-POTENTIALS. Norio Hoshizaki (Rikkyo Univ., Tokyo), Shoichiro Otsuki, Wataro Watari, and Minoru Yonezawa. Progr. Theoret. Phys. (Kyoto), 27: 1199-1220(June 1962). (In English)

Existence of bosons other than pions with strangeness zero is expected in the full-symmetry theory of the Sakata model, and ρ, ω, $\cdots$ mesons are, in fact, found. It is investigated whether these bosons could explain the nuclear forces, especially, the spin-orbit coupling interaction. Two possibilities are discussed: one is to identify the phenomenological potential with a sum of one-boson-exchange-potentials; and the other is to explain the phenomenological potential by the one-pion-exchange potential, two-pion-exchange potential, together with a sum of one-boson-exchange potentials. The analyses show the presence of an $I = 1$ vector boson (mainly interacting through tensor coupling) for both possible cases. They may be identified as the ρ and ω meson respectively. In addition, an $I = 0$ scalar boson is needed for the first case, and an $I = 0$ scalar or pseudoscalar boson is required for the second case. Existence of other bosons is not necessarily excluded. Consistency of the results with experimental evidence and with the mass level scheme of the Sakata model is discussed. (auth)

13590 DECAY SCHEME OF THE Te^{131} ($T_{\frac{1}{2}}$ = 30 HRS). ISOTOPE. A. I. Bedescu-Singureanu (Inst. for Atomic Physics, Bucharest). Rev. Phys., Acad. Rep. Populaire Roumaine, 7: 173-82(1962). (In Russian)

An attempt was made to determine more precisely the complex decay scheme of the $T_{\frac{1}{2}}$ = 30-hr half life of the $_{52}Te^{131}_{79}$, measuring at the same time the excited levels of $_{53}I^{131}_{78}$. The material needed was obtained by irradiating Te metal containing 99.9% Te^{130} to a thermal neutron flux of a reactor; this yielded the 30-hr and 25-min half life of Te^{131} isomers. The I^{131} decay product was removed from the aqueous solution by extraction with CCl_4; the resulting $Te^{131}O_2$ was used as source. It was found that the $g_{\frac{7}{2}}$ and $d_{\frac{5}{2}}$ states, possibly also the 0.6 and 0.92-Mev $2d_{\frac{3}{2}}$ and $3s_{\frac{1}{2}}$ states predicted by the single-particle model represent the ground and the first excited states of I^{131}. The excited states of I^{131} were also found to form 2 separate level systems, depending whether they have positive or negative parity. In the case of the levels of isotopes $_{53}I^{127}_{74}$, $_{53}I^{129}_{76}$, and $_{53}I^{131}_{78}$ the neutron pairs occupy the same level which has sufficient capacity to accomodate 6 particles. In the absence of reliable quantum data of the most excited states of the $_{53}I^{125}_{72}$, $_{53}I^{127}_{74}$, and $_{53}I^{133}_{80}$ isotopes, the existence of other levels could not be confirmed. (TTT)

13591 NUCLEAR MODELS AND SURFACES. David R. Inglis (Argonne National Lab., Ill.). Revs. Modern Phys., 34: 165-72(Apr. 1962).

A comparison is made of the results of shell-type and cluster nuclear models for light nuclei. Conceptual problems within the models, associated with the nature of the nuclear surface, are noted. Results are outlined for He^{6}, Li^{6}, Li^{7}, Be^{9}, He^{4}, and C^{12} as examples. Threshold states are investigated. The shell model for potential wells in heavy nuclei is discussed. (T.F.H.)

13592 DYNAMIC NUCLEAR POLARIZATION. W. A. Barker (St. Louis Univ. and Argonne National Lab., Ill.). Revs. Modern Phys., 34: 173-85(Apr. 1962).

Dynamic nuclear polarization (i.e., first-order orientation) is reviewed theoretically, with particular attention to spin $I = \frac{1}{2}$ nuclei. Spin hamiltonians, eigenvalue equations, population distributions, and resonance enhancement are considered. Results for H, D, Li^{7}, C^{13}, F^{19}, Na^{23}, Al^{27}, Si^{29}, Mn^{52}, Mn^{54}, Co^{59}, Co^{60}, As^{76}, and Sb^{122} are tabulated. (T.F.H.)

13593 COMPILATION OF HYPERFRAGMENT BINDING ENERGIES. N. Crayton (Univ. of Chicago), R. Levi Setti, M. Raymund, O. Skjeggestad, D. Abeledo, R. G. Ammar, J. H. Roberts, and E. N. Shipley. Revs. Modern Phys., 34: 186-9(Apr. 1962).

The analysis of π^{-}-mesonic decays is used to determine the binding energies of the Λ hyperons in $_{\Lambda}H^{3}$, $_{\Lambda}H^{4}$, $_{\Lambda}He^{4}$, $_{\Lambda}He^{5}$, $_{\Lambda}He^{7}$, $_{\Lambda}Li^{7}$, $_{\Lambda}Li^{8}$, $_{\Lambda}Li^{9}$, $_{\Lambda}Be^{8}$, $_{\Lambda}Be^{9}$, B^{11}, $_{\Lambda}B^{12}$, and $_{\Lambda}C^{13}$. (T.F.H.)

13594 (p,n) AND (p,2n) REACTIONS AND THE ORIGIN OF BYPASSED NUCLEI. D. A. Frank-Kamenetskii. Soviet Astron. AJ (English Transl.), 5: 66-71(July-Aug. 1961).

Possible ways of formation of nuclei with a proton excess, which do not lie along the path of neutron capture, are analyzed. The observed abundances indicate these nuclei are formed by two successive (p,n) reactions or one (p,2n) reaction. The same reactions can be regarded as a source

of neutrons for the synthesis of heavy nuclei. The necessary protons with energies of several Mev should be formed in cold-acceleration processes. (auth)

13595 ENERGY DISTRIBUTION OF INELASTICALLY SCATTERED ELECTRONS IN SOLIDS. I. M. Bronshtein and V. S. Kovalenko (Gertsen State Pedagogical Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 4: 1501-2(Feb. 1963).

It is shown that the energy distribution of inelastically scattered electrons is independent of the atomic number of the target. (auth)

13596 DEPENDENCE OF QUANTUM YIELD OF THE X-RAY PHOTOEFFECT OF A MASSIVE CATHODE ON THE STATE OF POLARIZATION OF THE RADIATION. M. A. Rumsh and V. N. Shchemelev (Leningrad State Univ.). Soviet Phys.-Solid State (English Transl.), 4: 1503-8(Feb. 1963).

The effect of the directed velocities of photoelectrons on the intensity of external emission from a massive photocathode was investigated. It is shown that the quantum yield of the external photoeffect depends on the state of polarization of the x radiation in the case where the photoeffect is due essentially to photoelectrons and not to Auger electrons. The variation of quantum yield due to the change in the polarization state of x radiation was measured, and on the basis of these results the difference in the decrease of the intensity of directed electron beams and electron beams scattered by diffusion was calculated. It is shown that the quantum yield is practically independent of the state of polarization of x radiation when the photoeffect is created essentially by Auger electrons. (auth)

13597 EMISSION AND SCATTERING OF γ-QUANTA BY NUCLEI OF A SOLID IN THE PRESENCE OF A TIME-DEPENDENT EXTERNAL EXCITATION. I. P. Dzyub and A. F. Lubenko (Inst. of Physics, Kiev). Soviet Phys.-Solid State (English Transl.), 4: 1524-9(Feb. 1963).

A theory was developed for the emission and scattering of γ quanta by nuclei of a solid in the presence of an external time-dependent excitation. The form of the emission and scattering spectra was calculated assuming that the external excitation is periodically dependent on time. It is shown that the presence of such excitation leads to the appearance of other Mössbauer lines in addition to the principal lines; in the scattering spectrum the principal line appears with observation at the Bragg angle. The angle at which the additional lines become visible depends on the wave vector of the lattice vibrations induced by the external excitation. The latter enables the frequency spectrum of the normal vibrations of the solid to be determined from the spectrum of the scattered γ quanta. (auth)

13598 STUDY OF FISSION BY NEUTRON SPECTROSCOPY. M. I. Pevzner. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 75-9(1962). (In Russian)

Some results obtained by neutron spectroscopy in the study of fission physics are considered. (auth)

13599 SPECTRA OF γ RAYS FROM NEUTRON CAPTURE BY HEAVY NUCLEI. L. V. Groshev, A. M. Demidov, and V. I. Pelekhov. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 81-94(1962). (In Russian)

Recently spectra of γ rays from thermal neutron capture were measured for a number of elements. Some characteristic features of these spectra for heavy elements (A = 110–200) situated some distance from the magic nuclei are considered. (auth)

13600 THE ANALYSIS OF STATISTICAL METHODS OF LIFE TIME DETERMINATION. G. E. Chikovani. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 131-59(1962). (In Russian)

The distribution of experimentally determined lifetimes and its reciprocal is given, depending on the number and the potential time of observation. Different methods of determination and the role of different errors are analyzed. (auth)

13601 PRODUCTION OF HYPERNUCLEI IN COLLISIONS OF Λ^0-PARTICLES WITH NUCLEI. S. G. Matinyan. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 173-81(1962). (In Russian)

Mechanisms of Λ^0 exchange with nucleons leading to hypernuclei production in light elements (C, N, O) are investigated. Calculation of the corresponding cross section gives a value to 60A for the upper limit, where A is the number of nucleons of the nucleus. (auth)

13602 INVESTIGATION OF ANGULAR DISTRIBUTION OF INELASTICALLY SCATTERED DEUTERONS ON NUCLEUS OF Mg^{24} WITH THE EXCITATION OF THE LEVEL 4^+ (4.12 Mev). T. I. Kopaleishvili and I. L. Ratishvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 197-202(1962). (In Russian)

Inelastic scattering of deuterons on Mg^{24} with excitation of the 4^+(4.12 Mev) level is considered. Calculations are made according to the theory of direct interactions. It is shown that theoretical angular distributions coincide with the experimental curve only at large angles. (auth)

13603 DEUTERON STRIPPING STUDY OF CERTAIN EIGHTY-THREE NEUTRON NUCLEI. Felton Wells Bingham. Thesis, Bloomington, Ind., Indiana Univ., 1962. 139p.

An 11-Mev deuteron beam and a 180° double-focusing magnetic spectrometer were used to measure Q-values, cross sections, and angular distributions for the reactions: $Ba^{138}(d,p)Ba^{139}$, $La^{139}(d,p)La^{140}$, and $Pr^{141}(d,p)Pr^{142}$. Since each of the stripping reactions adds a neutron to a nucleus with 83 neutrons, information was thereby obtained on the states excited in nuclei with one neutron outside the shell closed with the eighty-second neutron. In the La and Pr cases, the neutron deposited by the stripping reaction interacts with an unpaired proton to produce complex level schemes. The reaction on Ba leads to nuclear states that are primarily single-particle in nature. To analyze the angular distributions obtained for the well resolved states, a distorted wave Born approximation stripping theory was used. Comparison of an experimental angular distribution with the prediction of the theory allowed, in nearly all cases, determination of the orbital angular momentum transferred by the captured neutron to the residual nucleus. In Ba^{139} Q-values were obtained for seven levels; the configuration of the captured neutron and, hence, nuclear spins and parities were obtained for five of them. The results were (with Q-values given in Mev) 2.50 ($f_{5/2}$), 1.91 ($p_{3/2}$), 1.42, 1.10, 0.82 ($f_{5/2}$), 0.39 ($p_{3/2}$), and 0.05 ($p_{1/2}$). The level at 1.10 Mev yielded an angular distribution indicative of a neutron assignment of either $h_{9/2}$ or a mixture of f-wave with other neutron states. In La^{140} the following Q-values and nuclear configurations were observed: 2.86 ($g_{9/2}f_{5/2}$), 2.61 ($g_{9/2}f_{7/2}$), 2.26 ($g_{9/2}p_{3/2}$), 2.15 ($g_{9/2}p_{1/2}$), 1.02 (either $g_{9/2}f_{5/2}$ or $g_{9/2}p_{3/2}$), 1.55, 1.49, 1.46, 1.06, 0.98, 0.91, and 0.73. In Pr^{142} the levels and nuclear configurations obtained were 3.54 ($d_{5/2}f_{5/2}$), 2.92 ($d_{5/2}p_{3/2}$), 2.52 ($d_{5/2}p_{1/2}$), 1.38 ($d_{3/2}p_{3/2}$), and 2.12. (P.C.H.)

13604 DETERMINATION OF THE SPIN OF $_{\Lambda}Li^{7}$ FROM FINAL-STATE NUCLEAR INTERACTIONS. Timothy Duncan Sanders. Thesis, Stanford, Calif., Stanford, Univ., 1962. 1962. 101p.

Angular distributions and decay rates at the resonance energy were calculated for $_{\Lambda}Li^{7}$, both for the case in which the nucleon is a neutron and for the case in which the nucleon is a proton. In the calculations it was assumed that the interaction of the pion with nucleons in the final state is negligible, and that the nucleon-Li^{6} interaction can be represented by a complex square-well potential. Furthermore, it was also assumed that a suitably chosen square well adequately represents the Λ-Li^{6} potential, and that the weakly bound Λ decays like a free Λ. The spin of $_{\Lambda}Li^{7}$ may be either 1/2 or 3/2. Angular distributions and decay rates for each of the possible spins were calculated and it was found that the calculated quantities differ, depending upon which value we assume for the spin. Angular distributions and values of the decay rate obtained from the model are quoted for each of the possible spins of $_{\Lambda}Li^{7}$. Comparison of these with appropriate experimental data may be expected to yield a determination of the $_{\Lambda}Li^{7}$ spin. (P.C.H.)

13605 A STUDY OF NEUTRON PRODUCING REACTIONS BY DEUTERON BOMBARDMENT OF B^{11}. Hee J. Kim. Thesis, Cleveland, Case Inst. of Tech., 1962. 46p.

The neutrons produced by deuteron bombardment of thin, enriched B^{11} target were studied for nine different deuteron energies ranging from 1.60 to 2.70 Mev. The absolute differential cross sections for the production of neutrons feeding well established states in C^{12} were determined. Besides the monoenergetic neutron groups feeding the states of C^{12}, previously unreported continuum neutrons due to many body break-up of deuteron plus B^{11} system were observed and analyzed. The break-up mechanism is inferred to be a direct reaction process rather than the compound nucleus process. The angular distributions of neutrons leaving C^{12} in 15.11 Mev (1^{+}), Q = 1.37 Mev and 12.73 Mev (1^{+}), Q = +1.00 Mev states were studied in detail. The effect of compound resonance at E_d = 2.18 Mev on the angular distributions of the above neutron groups was studied. The investigations were performed employing time-of-flight technique utilizing pre-acceleration pulsed, post-acceleration bunched deuteron beam from a 3 Mev Van de Graaff accelerator. (Dissertation Abstr., 23: No. 6, Dec. 1962)

13606 DIFFERENTIAL CROSS SECTIONS OF THE $Li^{6}(N^{14},\alpha)O^{16}$ AND $Li^{7}(N^{14},\alpha)O^{17}$ REACTIONS. John Wells Wachter. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1962. 114p.

Angular distributions of α-particles from the bombardment of thin targets of metallic Li^{6} and Li^{7} by 27.6-Mev incident nitrogen ions were measured. Both α and recoil particles were detected in coincidence by Si surface-barrier diodes. Li^{6} cross section measurements included only reactions in which the O^{16} recoil was left in its ground state; Li^{7} measurements did not resolve reactions leading to the ground state and the 870-Kev excited state of O^{17}. The Li^{6} distribution exhibits a strong forward peak of 100 μb/sr at 0° (cm) falling off, with some structure, to 14 μb/sr at 90°. In the backward direction, a broad peak extends from 90 to 135° with a maximum of 23 μb/sr at 112°. The cross section then rises to a backward peak of 125 μb/sr at 165°. The Li^{7} distribution falls from 125 μb/sr at 0° to 26 μb/sr at 90° and rises to 75 μb/sr at 135° without clearly defined structure in the backward direction or symmetry with the cross section at the forward angles. The total cross sections were 0.40 mb ± 29% and 0.44 mb ± 36% for the Li^{6} and Li^{7} cross sections, respectively. The asymmetry of the angular distribution and the energy dependence of the emitted alpha particles further confirm the identification of the reactions as direct processes involving a deuteron transfer from the Li^{6} and a triton transfer from the Li^{7}. A computation of the $Li^{6}(N^{14},\alpha)O^{16}$ deuteron pickup reaction was made using the Bassel-Drisko-Satchler formulation of the distorted wave Born approximation. The data were found to agree with the predicted angular distribution in the backward direction. (Dissertation Abstr., 23: No. 6, Dec. 1962)

13607 A STUDY OF NUCLEAR REACTIONS ON Sn^{112}, Sn^{114}, AND Sn^{115} USING 15 Mev DEUTERONS. Robert Eugene Price. Thesis, Pittsburgh, Univ. of Pittsburgh, 1962. 81p.

Targets enriched in Sn^{112}, Sn^{114}, and Sn^{115} were bombarded with 15-Mev deuterons. Outgoing particles were magnetically analyzed and detected in nuclear emulsions. Neutron single quasi-particle states were identified. Using distorted wave Born approximation calculations and an empirical method, v_j^2 were found; both methods gave reasonable results for the tin isotopes. The ϵ_j were found by using v_j^2 and by using the energy of the single quasi-particle levels (E_j); the ϵ_j from E_j were ~2 times as large as from v_j^2. They also agreed better with ϵ_j from other regions of the same shell. Levels in Sn^{112}, Sn^{114}, and Sn^{116} were compared with pairing theory plus quadrupole-quadrupole and octupole-octupole interactions. The energy shift of the 2^{+} and 3^{-} levels for the different isotopes of tin agreed well. Q values for (d,p) and (d,t) reactions on Sn^{112}, Sn^{114}, and Sn^{115} were also measured. (Dissertation Abstr., 23: No. 6, Dec. 1962)

Particle Accelerators

13608 (AWRE-NR-1/63) SHIELDING PROBLEMS ASSOCIATED WITH A COCKCROFT-WALTON ACCELERATOR. L. R. Day and M. L. Mullender (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Jan. 1963. 19p.

Neutron attenuation and flux in the 4.25-ft shielding used around a Cockcroft-Walton accelerator neutron source have been measured. Additional measurements of γ radiation from neutron capture in the shield and of x rays produced by the accelerator itself are also reported. Fast neutron relaxation length in the shield is found to be 15.0 ± 0.5 cm. Calculations of neutron fluxes and relaxation lengths and of γ radiation dose rates compare well with theoretical values. X-ray shielding is deemed adequate and the γ dose rate is found to be a fraction of the neutron dose rate. (D.C.W.)

13609 (BNL-6726) MODE IDENTIFICATION IN THE IRIS-LOADED WAVEGUIDE OF A RF PARTICLE SEPARATOR. H. Hahn and H. J. Halama (Brookhaven National Lab., Upton, N. Y.). Jan. 14, 1963, Contract [AT(30-2)-Gen-16]. 23p.

A description is presented concerning model measurements which were necessary to determine the geometry of brazed or electroformed prototypes for deflecting waveguides. A systematic investigation was also made of other than deflecting modes to ensure nondegenerate field solutions at selected operating frequencies. (J.R.D.)

13610 (BNL-6733) ON THE DESIGN OF QUADRUPOLE FOCUSING SYSTEMS. Internal Report. J. P. Blewett (Brookhaven National Lab., Upton, N. Y.). Oct. 2, 1958. Contract [AT(30-2)-Gen-16]. 12p.

Breaking the lens-system into two parts facilitates the problem of designing a quadrupole lens system to take a particle beam from given focal lines in the x and y planes to other focal lines. The first part of the system brings the initial beam parallel to the z-axis in both planes, and the second carries it to the final state. Calculations of the particle position and velocity through the quadrupoles are made, and expressions for the displacement are derived. Synthesis of a complete lens system from double quadrupole systems is also treated, and the anastigmatic properties are examined by considering the special case of a symmetric lens with f = f' = 1 m. Choice of parameters in system design and the procedure of designing a lens are discussed and illustrated. A table of parameters for anastigmatic lenses is included. (D.C.W.)

13611 (BNL-6734) BEAM SEPARATORS FOR Bev PARTICLES. J. P. Blewett (Brookhaven National Lab., Upton, N. Y.). Mar. 16, 1959. Contract [AT(30-2)-Gen-16]. 8p.

The problem of separating beams of particles with different masses but with the same momentum at Bev energies is examined. Differences in times of flight of different particles and the rapid decay of mesons provide little help in separation. Theory and design of electrostatic-electromagnetic beam separators are then discussed, and these separators are found practicable at energies up to 3 Bev. Radiofrequency separators are considered for higher energies. (D.C.W.)

13612 (BNL-6743) A RAPID BEAM DEFLECTOR FOR THE BROOKHAVEN AGS. Internal Report. H. N. Brown, B. B. Culwick, and E. B. Forsyth (Brookhaven National Lab., Upton, N. Y.). Oct. 2, 1962. Contract [AT(30-2)-Gen-16]. 31p.

Design and operation of an air cored pulse deflection coil (Rapid Beam Deflector) that has been in use at Brookhaven AGS for a year are discussed. For bubble chamber detection of charged particles from accelerators, beam pulse durations of 50 μsec or less are appropriate. The system discussed yields a deflecting pulse with a peak radial deflection of 2.5 cm, and duration of 70 μsec. Spill duration of 15 to 50 μsec from the target is readily achieved, and more than 50% of the circulating protons make nuclear collisions in the useful part of the target. Circuitry and graphs of characteristics are presented. Another such unit has been completed recently. (D.C.W.)

13613 (CREL-883) THE CHALK RIVER TANDEM ACCELERATOR DATA RECORDING AND PROCESSING SYSTEM. F. S. Goulding and W. D. Howell (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Nov. 1959. 19p. (AECL-1694)

A system of data collecting, recording, and processing units requiring little human attention is now in use with the Chalk River Tandem accelerator. Description of the 100-channel kicksorters and the transistorized scalers employed in data collecting is presented, as is similar information on the uniselector, electrical timing cycle, interlocks, encoder, readout programs for the kicksorters and scaling stations and punched tapes of the data recording system. Operation of these components is explained, and comments on reliability are included. Data processing is briefly treated, and block diagrams of components and sequences are given. (D.C.W.)

13614 (IS-313) INJECTION OF ELECTRONS INTO ANNULAR MACHINES. I. THE DYNAMICS OF THE INJECTED BEAM AND THE CENTRAL-SHIFT CAPTURE-MECHANISM. Luigi Gonella (Ames Lab., Ames, Iowa). Oct. 1962. Contract W-7405-eng-82. 126p.

A phenomenological description is given of the injection process in the high-current conditions normally used in conventional machines. The equilibrium conditions, where the space charge forces are equal to the focusing forces, cannot be used to define a space charge limit controlling the injection by a simple saturation effect. An equilibrium current density J_e which is used to gage the effect of the local space charge on the dynamics of the beam leaving the injector is defined. This is studied in a simple approximation, as a function of the initial current density and spread. The results are qualitatively generalized to realistic conditions. They leave the gun as a coherent beam, and for some turns before the order of the motion is disrupted, the beam pulsates in area while its center oscillates about the capture orbit. Since the initial current density is usually larger than J_e, the beam expands and hits the donut wall during the first turn; a part is lost and the center of the surviving part is shifted toward the capture orbit, so that most of its electrons are captured. The details of the process are discussed for single-turn and multi-turn injection; the results agree with the experimental evidence. Ways toward a possible increase of intensity are suggested. (auth)

13615 (TID-17835) RING MAGNET POWER SUPPLY RECTIFIER PHASE CONTROL FOR INITIAL ZGS OPERATION. W. F. Praeg (Argonne National Lab., Ill.). Oct. 31, 1962. 65p.

The main rectifier phase control circuit and the phase control bias supply (Customer's Bias) at the ZGS are described. By means of the Customer's Bias, the rectifier phase control is alternately shifted between inversion and rectification. The transition from rectification to inversion can be manually adjusted from approximately 4 ms to 300 ms in 3 ms steps. In addition, "hold" and "flat-top" periods in the magnet current ramp can be obtained inexpensively within limits set by the repeatability and stability of the motor generator output voltage. Functioning of the system is explained, and schematics and graphs of voltage and currents in various components are presented. (D.C.W.)

13616 ELECTROSTATIC CHANNEL FOR INJECTING AN ION BEAM INTO A MAGNETIC TRAP. V. A. Belyaev and N. N. Brevnov. At. Energ. (USSR), 13: 581-3(Dec. 1962). (In Russian)

Introduction of fast ions into a magnetic trap requires special injectors, designed to guide the ions by a definite trajectory which ensures the longest confinement period within the trap. Theoretical considerations indicated that an electrostatic channels may be used to good advantage whenever the magnetic field of the trap decreases rapidly. This problem was considered for injecting an ion beam into the magnetic trap "Ogrenok." The electrostatic compensation made it possible to deflect the beam under a definite angle with respect to the plane of injection, preventing it from hitting the channel wall. The channel consisted of a 25 and an 18-cm portion, the first of which took care of the electrostatic compensation of the deflection of the magnetic field of the trap, while the second one compensated for the deflection within the magnetic field. A 10-kev H_1^+ ion beam with a 1 ma current was introduced into the 1400 oersted field at its axis. (TTT)

13617 LINEINYE USKORITELI IONOV. (Ion Linear Accelerators). D. V. Karetnikov, I. N. Slivkov, V. A. Teplyakov, A. P. Fedotov, and B. K. Shembel'. Moscow, Gosatomizdat, 1962. 208p.

Systematic data are given on the theory, calculations, and construction of linear ion accelerators. Chapters cover the principles of linear accelerator operations,

particle motion, focusing, high-frequency acceleration systems, and injection devices. The electric stability of the vacuum isolation and parasitic loads are discussed as well as problems of high-frequency feed lines. 177 references are included. (R.V.J.)

Plasma Physics and Thermonuclear Processes

Refer also to abstracts 13863, 13865, and 13866.

13618 (ML-890) INTERACTION EFFECTS BETWEEN A PLASMA AND A VELOCITY-MODULATED ELECTRON BEAM. Scientific Report No. 38. Gabriel F. Freire (Stanford Univ., Calif. Microwave Lab.). Feb. 1962. Contract AF19(604)-1930. 128p. (AFCRL-62-82; AD-273706; N62-11080)

The interaction between a grid modulated electron beam of finite diameter and a stationary plasma column, in the absence of a magnetic field, is investigated both theoretically and experimentally. Experiments performed with a beam-plasma tube, with modulation of the electron beam by grids, reveal a maximum interaction when the modulation frequency of the beam is equal to or near the plasma frequency of the plasma. An electronic gain of 7.5 db due to the plasma is observed. The output powers are low with no net gain in any condition, due to the low impedances of the cavities that are used, and to the low beam current available. Nevertheless, it is possible, by driving the beam to saturation power levels, to obtain fundamental components of the beam current such that $I_1/I_0 = 1.5$ near the resonance condition. With only the electron beam on the plasma being off, the saturation output current measured is about 0.8 I_0. Second harmonic signals are detected, and a maximum peak of the output signal is observed when the plasma frequency of the plasma is twice the modulation frequency of the beam. Another smaller peak is observed at $f \sim f_p$. The second-harmonic currents are shown to increase approximately by a factor of two, at input saturation powers, when the plasma density is increased from zero to a value such that $f_p \sim 2f$. The theoretical model that is the subject of analysis consists of a perfectly conducting cylindrical waveguide completely filled by a lossless, uniform plasma. The electron beam is assumed to be modulated by a gridded gap. Two pairs of field solutions inside the beam region are shown to be possible. One pair of solutions, not excited with a gridless gap modulation, is associated with space-charge density variations inside the beam. The propagation constants of these volume space-charge waves are the same as in the infinite beam plasma system. The other pair of solutions for the electric fields within the beam corresponds to the condition for which there is no charge accumulation in the beam. These solutions are associated with charge rippling at the beam-plasma interface. The propagation constants of these surface waves depend on the transverse dimensions of the beam and plasma. These surface waves grow exponentially with distance, when $\omega < \omega_{pp}$, at a rate that is smaller than the growth rate of the volume space-charge waves. It was shown also that, under conditions for existence of growing waves in the system, strong harmonic generation becomes possible as a result of modifications of space-charge forces on the beam, due to the presence of the plasma. Expressions for the second-harmonic components of the relevant rf quantities in the infinite beam-plasma system are derived, indicating the existence of growing second-harmonics. (auth)

13619 (NASA-TN-D-1551) THE MAGNETIC FIELD OF A LINE CURRENT IN A TRANSVERSE RAREFIED PLASMA STREAM. Albert G. Munson (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.). Aug. 10, 1962. 21p.

The steady-state flow of an infinitely conducting, rarefied, neutral plasma past a line current is considered. According to the Chapman-Ferraro theory, the plasma is confined to the exterior and the magnetic field to the interior of a cavity, the boundary of which is a thin current sheath. Within these restrictions the problem is solved exactly by a method similar to the hodograph method of incompressible fluid dynamics, and the magnetic field inside the cavity is presented. Results of approximate and exact solutions are compared. (auth)

13620 (NBS-7644) ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD. Twelfth Progress Report, September 30, 1962 to December 31, 1962. (National Bureau of Standards. Boulder Labs., Boulder Colo.). Jan. 17, 1963. 6p.

Modification of the high vacuum deposition system to extend operating range and to aid in tunneling experiments is reported. Calculations of stress field effects of dislocations in niobium have been made for large filaments, giving an idea of the filament geometry when second order field penetration effects are negligible. Work on small filaments is being carried out. The power supply of the pulsed field magnet has been modified to yield a maximum field of about 75 kgauss. A dewar system built for cryogenic studies in the magnetic field will cool liquid helium to 1.2°K. An integrating circuit for the output of a search coil is used in determining the calibration constant of the solenoid. Operation "on paper" of a single engine "Class II" refrigeration cycle using the digital computer is reported for a wide range of temperatures with helium, hydrogen, and nitrogen as refrigerants. A single stage four-to-one pressure ratio turbine has given efficiencies of 63% at shaft speeds of 570,000 rpm using existing gas bearings at 300 psi. (D.C.W.)

13621 (NP-12517) THE EFFECT OF CLOSE COLLISIONS ON THE TWO-BODY DISTRIBUTION FUNCTION IN A PLASMA (thesis). Technical Report 402. David Ellis Baldwin (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). May 15, 1962. 60p.

This investigation is concerned with the development of a two-body distribution function in a plasma for use in a kinetic equation for the one-body distribution function. The kinetic equation is obtained for a uniform plasma for those circumstances in which the time dependence of higher-order distribution functions can be assumed to occur within a functional dependence on the one-particle distribution function. The conditions of validity for this functional-dependence assumption are discussed. The resulting interaction term is new in the sense that it contains no divergent integrals requiring cutoffs, and it may be considered accurate to first order in $(e^3/kT\lambda_D)$. The interaction term is composed of two parts. The first is a Boltzmann collision integral with a Debye-shielded interaction. The second term is due to the deviation of the shielding cloud from a Debye shield and is the Fokker-Planck form, the coefficients of which are finite and well-behaved. Because of its form, with a convergent collision integral and convergent Fokker-Planck coefficients, the solution may be considered as a joining of the previous solutions to this problem. (auth)

13622 (NP-12518) PERTURBATION OF A PLASMA BY A PROBE. Technical Report 406. John F. Waymouth

(Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). June 27, 1962. 47p.

In the analysis of current-voltage characteristics of a probe in a plasma, as originally developed by Langmuir, it is assumed that the mean-free path of all plasma particles is large in comparison with the probe dimensions, in order that the plasma density, temperature, and potential as derived from the measured characteristics be the same as those of the plasma undisturbed by the probe. When this condition does not hold, the plasma density and potential in the vicinity of the probe are different from those of the undisturbed plasma. The perturbation of the plasma by a probe is analyzed in this report as a problem in ambipolar diffusion, subject to the assumptions that the mean-free path of plasma particles is: (a) comparable to or smaller than probe dimensions, and (b) much greater than the thickness of any sheaths that may be present. Sheaths must therefore be assumed to be thin in comparison with probe dimensions. Analyses are carried through for spherical probes and for plane probes oriented normal to a magnetic field. The results can be expressed in terms of a parameter Q which is approximately equal at zero sheath potential to the sum of the ratios of probe size to electron mean-free path and probe size to ion mean-free path. Since Q also depends on sheath potential, the current-voltage characteristics are distorted. Methods for determining zero sheath potential and calculating the properties of the undisturbed plasma from the probe curves are given. (auth)

13623 (NP-12523) RESEARCH ON THE VORTEX MHD POWER GENERATOR. Third Quarterly Progress Report, January 1962. (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Contract NAS3-2526. 17p.

Efforts toward providing instrumentation for the vortex MHD generator tests and for the vortex chamber apparatus to be used in turbulent vortex flow studies are reported. The relations of nonequilibrium theories and Hall effects to the vortex MHD generator were studied leading to a consideration of controlling the Hall currents by cancellation with azimuthal currents induced by the radial component of fluid flow. The experimental model of the vortex MHD generator and its auxiliary apparatus, including instrumentation, were prepared for initial testing and evaluation. A device for seeding the plasma by atomizing and injecting cesium hydroxide into the arc heated Ar was developed. A gas dilution calorimeter was constructed for the purpose of determining enthalpy levels of the plasma supplied to and discharging from the vortex generator. Its operation was successful in a trial test. The water-cooled Cu nozzles developed for the vortex generator were operated under maximum power conditions and discharging into the atmosphere. No deterioration of the nozzles was evidenced and the operation otherwise appeared satisfactory. Instrumentation for the vortex flow apparatus was completed. Initial operation of this facility revealed some minor problems which have been, or soon will be, corrected. The performance of the vortex chamber device is expected to be satisfactory. A preliminary study of Hall current suppression in the vortex MHD generator revealed the conditions under which Hall effects can be usefully employed or, on the other hand, be diminished in their degrading influence. (auth)

13624 (NP-12542) PLASMA OSCILLATIONS AND PARTICLE TRAJECTORIES IN A DRIFTING ELECTRON STREAM; PALMER DIAGRAMS. C. K. Birdsall (California. Univ., Berkeley. Electronics Research Lab.). June 29, 1962. Contract AF 49(638)-102. 47p.

Electron trajectories are obtained for the Hahn-Ramo space-charge waves. The approach is to use Lagrangian form of hydrodynamic equations of motion and of continuity. This is in contrast with the more common Eulerian jellied-out fluid approach where the particle identity is lost. The one-dimensional model used is developed in some detail and is related to the fluid model. Trajectory plots are given for the faster and slower space-charge waves by themselves and for velocity modulation for the ratios of driving frequency to plasma frequency, ω/ω_p, of 0.5, 1.0, and 2.0. (auth)

13625 (PIBMRI-970-61) THE SPECTRUM OF ELECTROMAGNETIC WAVES GUIDED BY A PLASMA LAYER. T. Tamir and A. A. Oliner (Brooklyn. Polytechnic Inst. Microwave Research Inst.). Dec. 13, 1961. Contract AF19(604)-4143. 53p. (AFCRL-62-135; AD-278127)

The modal spectrum of a lossless, homogeneous and isotropic planar plasma layer is shown to contain contributions from surface waves and complex modes in addition to the usual continuous spectrum characteristic of open structures. These discrete contributions are only of the E-mode type and occur whenever the plasma dielectric constant (d-c) is negative. The surface waves may be of the forward or the backward type and they carry power in opposite directions in the plasma and air regions. The complex modes are shown to appear always in degenerate pairs and, as a consequence, they carry no real power but may account for large reactive fields in the neighborhood of sources. For E-modes with positive values of d-c and for all H-modes, the spectrum is purely continuous; however, non-spectral leaky waves are then present which are significant in radiation considerations. (auth)

13626 (RADC-TDR-62-352) STUDY AND INVESTIGATION OF DESIGN PARAMETERS OF HIGH POWER GASEOUS DISCHARGE SWITCHES. Final Progress Report. C. Ward and N. Brown (Microwave Associates, Inc., Burlington, Mass.). [1962]. Contract AF30(602)-2030. 106p. (AD-278233)

An investigation and study program was completed at L band to determine the limitations of a gas discharge as a high-power duplexer switch. The encapsulated window was investigated as a basic window element in fabricating high-power duplexers. A theoretical analysis of the plasma characteristics controlling arc loss and recovery time was made and correlated with experimental data. In an argon plasma electron densities the order of 5×10^{15} electrons per cc were computed and verified experimentally. The electron removal process associated with recovery time was analyzed as two mechanisms, recombination and diffusion. At low pressures, diffusion is the dominant mechanism and recovery time varies directly with pressure. At high pressure, recombination controls the plasma and recovery time is inversely proportional to pressure. With a knowledge of the arc loss characteristics of the plasma it was possible to compute the power absorbed within the window. A theory was developed that related the arc loss to window temperature. With this information, it was possible to compute the maximum power capability of the encapsulated window under given conditions with excellent accuracy. A high-power evaluation of a balanced ATR duplexer was successfully performed at 70 Mw peak power, 140 kw average power, and 6 μs pulse width at 1300 Mc. Reasonable agreement was obtained between the theoretical performance and experimental results. The bandwidth and high-power capabilities of the balanced pre-TR, balanced ATR, phase shift, and branch duplexer were calculated and

compared. For narrow band operation, the order of 1%, the branch duplexer was optimum, for 10 and 20% bandwidths the balanced ATR duplexer was optimum, for 30% the only feasible duplexer is the balanced pre-TR. (auth)

13627 (RISÖ-54) ON ION OSCILLATIONS IN A HOMOGENEOUS MAXWELLIAN PLASMA. V. O. Jensen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Dec. 1962. 19p.

It has been known for a long time that longitudinal ion oscillations in a collisionless Maxwellian plasma are damped by the Landau mechanism. The damping is very strong except when the electron temperature is much higher than the ion temperature. This paper contains a calculation of the phase velocity and the damping of longitudinal ion waves in a homogeneous Maxwellian plasma as a function of the ion temperature over the electron temperature. In the appendix the corresponding calculation is performed for a semi-collisionless plasma model where the ions are regarded as collisionless while the electrons obey an adiabatic hydrodynamic law. (auth)

13628 (TID-17888) THE USE OF ATOMIC BEAMS AS A PROBE FOR STUDYING LOW DENSITY PLASMAS. Quarterly Progress Report, October 1, 1962–December 31, 1962. Benjamin Bederson (New York Univ., New York). Jan. 1, 1963. Contract AT(30-1)-2397. 24p.

Measurements on the attenuation of a velocity selected potassium beam passing through molecular hydrogen, helium, neon, argon, and xenon gases at room temperature and at 200°C have been made. Similar measurements with molecular hydrogen, helium, and neon gases at −180°C are also reported. Difficulties with the wire used in the surface ionization detector, with drift of the electrometer used to measure the beam, and with the oven background of potassium atoms are examined; and corrective measures taken are explained. Data are analyzed using a function related to attenuation for the $v^{-\frac{1}{3}}$ cross section dependence predicted by Massey-Mohr theory. Comparison is made with Berkling's values calculated with varying velocity dependences, and the cross sections are seen to disobey a flat $v^{-\frac{1}{3}}$ velocity dependence. Difficulties in pumping alkali vapors through the tubulation to the charge transfer cell are discussed. Characteristics of the transfer tube are measured revealing close similarity to electron tube diode and triode characteristics. Data and characteristics are graphed. (D.C.W.)

13629 (TIL/T.5278) STUDY OF THE FARADAY EFFECT IN A PLASMA AT 10,000 Mc/s. M. Bonnet, M. Matricon, and E. Roubine. Translated from Ann. Telecommun., 10: 150-8(1955). 18p. (AD-272518; N62-11789)

An introduction on the nature of the phenomenon studied precedes an experimental study. The apparatus used to demonstrate the rotation of the plane of polarization in a circular wave guide for 3-cm waves is described, and some of the results obtained are given. A theoretical study based on the use of bicomplex numbers is presented as are the properties of an ionized medium in a uniform magnetic field. The equations of electromagnetic wave propagation in an anisotropic ionized medium that make it possible to solve the problem of propagation in an anisotropic plasma inside a circular guide are derived. (auth)

13630 EQUILIBRIUM OF A PLASMA TORUS IN THE MAGNETIC FIELD. V. D. Shafranov. At. Energ. (USSR), 13: 521-9(Dec. 1962). (In Russian)

The distribution of the magnetic field alongside the magnetic surface was determined by examining the equilibrium of forces acting on a wedge-shaped volume element formed by the rotation of the cross section of a sector of the magnetic surface around the axis of symmetry of the torus. The limiting conditions thus obtained were then used for calculating the external magnetic field required to maintain the toroidal plasma column in equilibrium. On the basis of the same assumptions formulas were derived for the shift of the toroidal column within the conducting shell, taking the b^2/R^2-order members into account, in which b designates the radius of the shell and R the large radius of the torus. (TTT)

13631 RADIATION FROM A LINE SOURCE IN A UNIAXIALLY ANISOTROPIC PLASMA. H. S. Tuan and R. S. Seshadri (Harvard Univ., Cambridge, Mass). Can. J. Phys., 41: 246-57(Feb. 1963).

Problems of radiation in a magnetized, incompressible plasma are investigated. The radiation characteristics of a line source of magnetic current are studied for the case in which the external magnetic field is infinite and oriented in a direction perpendicular to that of the source. A second problem treated is the radiation from a uniformly moving line charge. Two cases are considered, namely those in which the motion of the line charge is parallel or perpendicular to the direction of the external magnetic field. In each case it is found that there is a Čerenkov-type radiation for frequencies less than the plasma frequency. The frequency and the angular spectrum, as well as the total energy radiated per unit path length, are determined for both cases. (auth)

13632 PROBE STUDIES OF HELIUM AFTERGLOWS DOMINATED BY COULOMB INTERACTIONS. O. D. Olson and H. M. Skarsgard (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 41: 391-404(Feb. 1963).

Probe measurements of electron energy and density decays are carried out in low-pressure helium afterglows. The plasma is contained in a toroidal chamber. A weak, azimuthal magnetic confining field of 40 gauss is used. Strict criteria are satisfied to ensure reliable operation of the double probe employed for the measurements. Pressures used are in the range from 18 to 61 microns. The decay of electron density are found to be controlled by a type of ambipolar diffusion dominated by electron-ion collisions. The decay of electron energy is predominantly an equipartitioning process between the energetic electrons and the less energetic helium ions and atoms; electron-ion interactions account for the greater part of the cooling. Within certain limits the results confirm the applicability of the statistical theory employed to describe electron-ion interactions. The results also provide a test of the probe technique employed for the measurements. (auth)

13633 HEATING OF A PLASMA BY TRAPPING OF WAVES WITH RIGHT CIRCULAR POLARIZATION. Térenzio Consoli, Georges Ichtchenko, and Micheline Weill (Centre d'Études Nucléaires, Saclay, France). Compt. Rend., 255: 2394-6(Nov. 5, 1962). (In French)

The principle of a method of heating based on electromagnetic trapping of the energy transported by the wave is given. It is compared to the optical trapping of an infrared luminous wave. (tr-auth)

13634 HIGH FREQUENCY PLASMA JET. François Galtier, François Leprince-Ringuet, Jean Reboux, Robert Collongues, and Georges Chaudron. Compt. Rend., 255: 2539-41(Nov. 12, 1962). (In French)

Plasma jets constitute remarkable means for the production of temperatures higher than 5000°C. The different models of jets are distinguished by the mode of plasma

generation. In the apparatus described, the ionization of the plasmogenic fluid is assured by high frequency currents of inductive origin. The apparatus does not involve any electrode in contact with the plasma. Two essential advantages result for the chemist: first, the plasma undergoes no contamination and, secondly, it is possible to use varied fluids, either neutral (argon), for example, for the fusion of refractory metals sensitive to oxidation, or very reactive for the realization of various chemical syntheses. Some recent improvements, the most important of which is the superposition on the high frequency field of a direct or alternating electromagnetic field, have allowed the power dissipated in the plasma to be increased to a great extent, and possible application of this jet on an industrial scale to be envisaged. (tr-auth)

13635 IMPEDANCE METHOD FOR MEASURING HIGH ELECTRON DENSITY AND ELECTRON COLLISION FREQUENCY IN A GASEOUS PLASMA COLUMN. Susumu Takeda (Nagoya Univ., Japan). Japan. J. Appl. Phys., 2: 58-61(Jan. 1963). (In English)

The impedance method is extended to deduce simple and convenient formulas for measuring electron density higher than the critical value corresponding to the plasma resonance. The determination of both the electron density and the collision frequency in transient plasmas is possible by simultaneously recording two detected microwave signals. The electron density range measurable covers from 1×10^{12} to 5×10^{10} cm^{-3}, at a frequency of 9000 mc/sec. (auth)

13636 BACKWARD WAVES IN ANNULAR PLASMA COLUMNS. S. F. Paik (Raytheon Co., Burlington, Mass.). J. Electron. Control (1), 13: 515-24(Dec. 1962).

The waveguide properties of annular-shaped plasma columns in the absence of an external magnetic field are investigated. The analysis of the structure shows several novel characteristics of the propagation system. The modes of propagation on an annular plasma column are surface-wave modes, one on the inner surface and one on the outer surface. The dispersion relations obtained from the field analysis is plotted, and it is shown that the inner surface wave is a backward wave. When a conducting cylinder is placed on one surface of the annulus one obtains single-mode solutions, since the other mode is shorted out by the conductor. It is shown that the surface waves in the presence of a conducting boundary also exhibit pronounced backward-wave characteristics. The dispersion curves for these propagation systems are plotted. (auth)

13637 THE DIELECTRIC COEFFICIENT OF A PLASMA. S. J. Buchsbaum (Bell Telephone Labs., Murray Hill, N. J.) and Sanborn C. Brown. J. Electron. Control (1), 13: 573-5(Dec. 1962).

An experiment is described which indicates that the Lorentz polarization term should not be present in the expression for the dielectric coefficient of a plasma. (auth)

13638 MEANING OF EQN. (13) IN 'CURRENT-VOLTAGE BEHAVIOUR IN A PLASMA.' Louis Gold (Kennecott Copper Corp., Lexington, Mass.). J. Electron. Control (1), 13: 577-8(Dec. 1962).

In a previous paper (J. Electron. Control 5: 432(1958)), an analytical solution with an implicit form was derived for the current-voltage behavior of plasma. By introducing two new variables $\bar{J}$ and $\bar{V}$ for a plasma diode, the solution becomes $\bar{J} = \rho_+^{\frac{1}{2}} [\sin^{-1}(\bar{V} - 1) - \sin^{-1}(-1) - \sqrt{(2\bar{V} - \bar{V}^2)}]^{-1}$. This equation is shown to have strange properties; at $V > 2$, complex behavior sets in with resultant unstable or oscillatory behavior of the plasma diode. At $V = 2$, it is shown that $qV_+^2 = 2mv^2 (\rho_- \rho_+)^2$. (D.L.C.)

13639 X-RAY SPECTROSCOPIC MEASUREMENTS OF A HIGH-TEMPERATURE PLASMA. G. A. Sawyer, F. C. Jahoda, F. L. Ribe, and T. F. Stratton (Los Alamos Scientific Lab., N. Mex.). J. Quant. Spectry. Radiative Transfer, 2: 467-75(Oct.–Dec. 1962).

The x-ray spectrum emitted from the deuterium plasma in the Scylla fast magnetic compression experiment is studied with a beryl single-crystal x-ray-diffraction spectrometer. Prominent lines are identified from the HeI-like spectra of Na X, Mg XI, Al XII, and Si XIII wall impurity ions as well as the H-like Lyman series of O VIII. The shape and absolute magnitude of the continuum spectrum indicate that the plasma electron temperature is 345 ± 40 ev and that the soft x-radiation arises primarily from electron recombination with small amounts of highly stripped impurity ions. Broadening measurements of the spectral lines in the x-ray region show that the Doppler temperature of impurity ions is considerably greater than the corresponding deuterium ion temperature. (auth)

13640 THE SPECTROSCOPY OF NON-THERMAL PLASMAS. R. Wilson (Culham Lab., Abingdon, Berks, Eng.). J. Quant. Spectry. Radiative Transfer, 2: 477-90 (Oct.–Dec. 1962).

The development of controlled thermonuclear research presents problems different from those generally treated by the astrophysicist. These differences can be mainly ascribed to the non-thermal nature of the high temperature laboratory plasma. The problems posed by this type of plasma, and progress toward their solutions, are outlined. (auth)

13641 VACUUM ULTRAVIOLET RADIATION FROM A MAGNETICALLY COMPRESSED PLASMA. A. H. Gabriel, G. B. F. Niblett, and N. J. Peacock (Atomic Weapons Research Establishment, Aldermaston, Berks, England). J. Quant. Spectry. Radiative Transfer, 2: 491-502(Oct.–Dec. 1962).

Characteristics of radiation emitted by hydrogenic plasma at a particle density of 10^{17} cm^{-3} and temperature of 10^7°K, containing a small admixture of oxygen and permeated with an axial magnetic field of some 50 kG, are reviewed. The distribution of the ionic species in steady state conditions is discussed and the contribution of free-free, free-bound, and bound-bound transitions to the radiation spectrum is evaluated. Phenomena such as Stark broadening, Doppler shifts, and Zeeman splitting are considered as physical processes that can be used to diagnose the state of the plasma. Experimental vacuum ultraviolet radiation measurements are described. Soft x-ray pinhole camera photographs are used to establish the dimensions of the emitting plasma and absorption measurements using aluminum, beryllium, carbon, and nickel foils provide estimates of the electron temperature from the short wavelength spectral cut-off. Several instruments are constructed: a versatile x-ray crystal spectrometer; a grazing incidence spectrograph available with photoelectric recording; and a photographic instrument that uses a concave grating at near normal incidence, and which is time-resolved by reflection at 70° from a high speed rotor. (auth)

13642 RADIATION FROM HIGH-TEMPERATURE COLLISION-DOMINATED PLASMAS. H. R. Griem and A. C. Kolb (Univ. of Maryland, College Park and U. S. Naval Research Lab., Washington, D. C.). J. Quant. Spectry. Radiative Transfer, 2: 503-8(Oct.-Dec. 1962).

Almost completely ionized hydrogen and helium plasmas with electron densities ranging from 10^{17} to 10^{19} cm^{-3} are produced in electromagnetic T-tubes. The shock-heated

plasmas attain local thermal equilibrium in times shorter than cooling times and act therefore as spectroscopic light sources. Since it is necessary for many investigations to build the entrance slit of the vacuum monochromator spectrograph directly into the shock tube wall to minimize absorption, a rugged detector is developed in which only the photosensitive surface is in the differentially pumped volume. Photoelectrons are then accelerated to 20 or 30 kv and finally detected by a standard plastic scintillator-photomultiplier combination. This method alleviates normal deterioration of dynodes in open photomultiplier tubes and scattered light problems encountered with usual scintillator-photomultiplier combinations. An attempt is made to measure the Stark profiles of Lyman α and β at high electron densities where Doppler broadening is only a small correction. Since α is mainly broadened by electron impacts and β by the quasi-static action of ions, it would be possible to separate the two broadening mechanisms experimentally, thus providing a more direct check on the theory than by the measurement of Balmer line profiles. In another experiment the oscillator strength of the neutral helium resonance line is measured. A 10 per cent determination might be possible so that a comparison of the measured value with calculated oscillator strengths would help to decide which of the various approximations employed is the more appropriate. Again the answer to this theoretical question will be clearer than that obtainable from measurements of visible line intensities since the determination of the ground state wave function is most sensitive to the approximation scheme. In a third experiment the radiation from a high pressure T-tube is utilized for absolute intensity calibration in the vacuum uv region. This is possible because for collision-dominated hydrogen and helium plasmas the emitted spectrum can be calculated from temperature and electron density, which are obtained from measured line and continuum intensities in the visible. (auth)

13643 ULTRAVIOLET RADIATION FROM STRONG SHOCKS. B. Kivel (Avco-Everett Research Lab., Everett, Mass.). J. Quant. Spectry. Radiative Transfer, 2: 509-16 (Oct.-Dec. 1962).

U-v radiation studies are used in three ways: chemical kinetic studies of high temperature air; bremsstrahlung and molecular radiation in the windowless u-v region from 300 to 1200 Å; and a fast bolometer to measure from 20 μ to 20 Å gas radiation. The dissociation and vibration excitation rates of O_2 and NO are determined by measuring the transmission of u-v radiation at 1470 and 1270 Å through shocks in air and component gases. In these studies it is necessary to understand the temperature dependence of the absorption coefficients, e.g., that of oxygen at 1470 Å decreases with increasing temperature. At 1270 Å there is a strong absorption by a high vibration state of nitrogen, which is probably related to the $b'^1\Sigma \rightarrow X^1\Sigma$ transition with an electronic f-value of about 0.1. In the windowless u-v region a tungsten photoelectric absorption gauge is used, and studies are made of the radiation from shocks in air at 0.7 cm/μsec and in hydrogen at 25 cm/μsec. The measurements of the u-v component from air shocks are correlated with the absorption measurements at 1270 Å by vibrationally excited molecular nitrogen. The fast bolometer has a thin layer of carbon, which is black from 20 μ to 20 Å. The radiation absorption is determined by observing the temperature rise of the absorber by observing the i-r emission from its back. This gauge works in the presence of strong electric and magnetic fields and has a rise time of less than 0.1 μsec. (auth)

13644 EXPERIMENTS ON THE PROBLEM OF CONTROLLED THERMONUCLEAR REACTIONS. R. S. Pease (Culham Lab., Abingdon, Berks, Eng.). Nature, 196: 1247-53(Dec. 29, 1962).

A general discussion of the conditions necessary for confinement of a plasma in magnetic fields precedes accounts of research on Zeta. Plasma losses, stability, and confinement are examined, and confinement in Zeta is noted to be destroyed by instabilities. Collective motion of the plasma is briefly considered, and research with the hard-core configuration and cusp geometry are summarized. Simple infinite-conductivity hydromagnetic theory is found unable to predict the stabilities in the hard-core configuration. The cusp geometry arrangements display none of the pinch systems' instabilities. (D.C.W.)

13645 CAN WE MASTER THE THERMONUCLEAR PLASMA? J. B. Adams (United Kingdom Atomic Energy Authority, Culham, Oxfordshire, Eng.). New Scientist, 17: 222-5(Jan. 31, 1963).

The principles of a fusion reactor are considered briefly. The problem of plasma instabilities and ways of overcoming this problem are discussed in some detail. A brief conjecture is made on the future development of fusion reactors. (D.L.C.)

13646 DERIVATION OF CAUCHY INTEGRAL TYPE DISPERSION FORMULA FOR MAGNETOPLASMA WAVES. Yasutomo Ozawa, Ikuo Kaji, and Masafumi Kito (Kokkaido Univ., Japan). Nippon Genshiryoku Gakkaishi, 4: 851-6 (Dec. 1962). (In English)

The dispersion formula of Cauchy integral type for longitudinal plasma waves in a magnetic field is exactly derived, in order to obtain a general instability criterion for magnetoplasma waves, on the basis of Vlasov's collision-free kinetic equation for arbitrary velocity distributions. The motion of the ions is taken into account. The formula important for the drift instability is written. Terms are discussed that correspond to the dispersion relation either for the case of strong magnetic field approximation or for the case of grazing angle propagation; that contribute to the drift instability in the case of wave propagation at an appreciable angle to a finite magnetic field; and that give rise to instability because of anisotropic velocity distributions. (auth)

13647 ON THE RELATION BETWEEN LANDAU DAMPING AND ENERGY ABSORPTION. A. Kildal (Univ. of Bergen, Norway). Phys. Letters, 3: 80-1(Dec. 1, 1962). (In English)

Two ways of correcting a previous calculation of Landau damping (γ) from the point of view of energy absorption of resonant particles are presented. An error of a factor $\frac{1}{2}$ in the previous calculation is shown to be due to a consideration of only the loss of electric energy and not the loss of kinetic energy from the main plasma. The two methods explored are shown to yield identical corrected expressions for γ. The invariance of γ with respect to Galilean transformations is briefly discussed. (H.D.R.)

13648 DYNAMICAL AND STATISTICAL CORRELATIONS IN AN ELECTRON GAS. W. H. Young (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 129: 2019-23(Mar. 1, 1963).

In the Cowan-Kirkwood treatment of an electron gas, one particle is singled out and the relative motion described. The density for the new problem is then related to the pair function for the original. Two effects omitted from this model, the considerable velocity of the chosen particle and its statistical interaction with the remainder, are included

in the present treatment. The pair function is considerably altered in detail but a calculation at a typical metallic density indicates that the two effects compensate energetically. This explains the success of the simple Cowan-Kirkwood treatment in this region. There are reasons why the present formulation should have a wider range of applicability than the original method. (auth)

13649 OBSERVED DISRUPTION OF INTENSE RUNAWAY ELECTRON STREAMS. L. T. Shepherd and H. M. Skarsgard (Univ. of Saskatchewan, Saskatoon, Can.). Phys. Rev. Letters, 10: 121-3(Feb. 15, 1963).

Attempts to produce self-focussing, relativistic electron streams by applying a strong betatron field to plasma in a doughnut chamber, thereby accelerating electrons to high energies, have resulted in intense initial ranaway electron streams that are disrupted soon after formation. The mechanism of disruption is unknown, but two possibilities are discussed. (D.C.W.)

13650 TRANSPORT PHENOMENA IN A NONUNIFORM SLIGHTLY IONIZED GAS. S. Zivanovic and M. S. Sodha (Illinois Inst. of Tech., Chicago). Progr. Theoret. Phys. (Kyoto), 27: 1128-36(June 1962). (In English)

The solution of Boltzmann's equation for electrons in a nonuniform slightly ionized gas is obtained, in the presence of gradients in the electron collision frequency, electron density, external static and alternating electric fields, and static magnetic field. Electrical and thermal currents are obtained in the integral form as a function of collision frequency and f_0, the isotropic part of the distribution function of electron velocities. A linear ordinary differential equation for f_0 involving collision frequancy as well as external fields and gradients of electron density and collision frequency is set up. One result obtained is that high gradients of electron density and collision frequency lead to a non-Maxwellian distribution of electron velocities. This outcome is applicable to problems involving plasma sheaths. Another result, clearly brought out by the vector treatment, is that the current in general has a part proportional to the magnetic vector, as well as parts proportional to the electric-field and field-gradient vectors and their vector product with the magnetic vector. However, this part vanishes when the magnetic vector is perpendicular to the electric-field and field-gradient vectors. Applications and limitations of the analysis are discussed. (auth)

13651 HELICAL OSCILLATION MODES IN CYLINDRICAL PLASMAS AND THEIR INSTABILITY. I. THE CASE OF WEAKLY IONIZED PLASMAS. Yoshi H. Ichikawa, Setsuo Misawa, and Yutaka Sasakura (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 27: 1277-8(June 1962). (In English)

A general theory for helical oscillation modes in weakly ionized plasma is developed, regarding the electron and ion density fluctuations as independent dynamical variables. The instability criterion for the instability of these modes is derived. (T.F.H.)

13652 HELICAL OSCILLATION MODES IN CYLINDRICAL PLASMAS AND THEIR INSTABILITY. II. THE CASE OF HIGHLY IONIZED PLASMAS. Yoshi H. Ichikawa, Setsuo Misawa, and Yutaka Sasakura (Nihon Univ, Tokyo). Progr. Theoret. Phys. (Kyoto), 27: 1279-80(June 1962). (In English)

The screw instability in highly ionized plasma is examined theoretically. A criterion is derived for the existence of the helical instability. The results are compared with experimental observations. (T.F.H.)

13653 SHOCK WAVES IN DEGENERATE PLASMA GASES. Yasuo Tanaka and Yôrô Ôno (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 27: 1280-2 (June 1962). (In English)

A quantative study is made of the propagation of stationary shock waves in plasmas whose electrons are almost totally degenerate. The astrophysical implications of the results are discussed. (T.F.H.)

13654 ION ENERGY ANALYZER FOR PLASMA MEASUREMENTS. H. P. Eubank and T. D. Wilkerson (Princeton Univ., N. J.). Rev. Sci. Instr., 34: 12-18(Jan. 1963). (MATT-121)

Flux measurements of low-energy neutral and charged particles provide direct knowledge of plasma composition and energy distribution. A particle analyzer is described for the energy range between a few electron volts and several thousand electron volts, which is sensitive to single ions and has an inherent time resolution of less than 50 μsec. Experimental results are given for both energy and mass analysis of positive ions ejected by a pulsed-arc plasma gun. Significant variations in composition and energy distributions are observed with variations in gun voltage. Results are presented on the detection of low-energy neutral particles. (auth)

13655 TWO HIGH VELOCITY PLASMA GUNS. D. C. Hagerman and J. E. Osher (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 34: 56-60(Jan. 1963). (LADC-5469)

The design and operating parameters of two coaxial plasma guns are described. The high-speed gun performance depends upon the use of gas valve ports near the muzzle end of the central electrode, an optimized gas diffusion delay time, and a small injected gas load. The 10-cm-diam gun employs a low inductance power supply and a light gas load to yield a plasma containing $\sim 5 \times 10^{16}$ D^+ ions with a mean energy of 13 kev. The larger 2.5-cm-diam gun requires more energy and a larger gas load to yield a plasma containing a similar number of D^+ ions but at a higher mean energy of ~20 kev. As an example of gun performance, the 25-cm-diam gun produces a neutron yield of $\approx 10^8$ when incident upon a D_2O ice target located 3 m from the gun muzzle. (auth)

13656 LOW-TEMPERATURE PLASMA DIFFUSION IN A MAGNETIC FIELD. F. C. Hoh (Royal Inst. of Tech., Stockholm and Advanced Kinetics, Inc., Mesa, Calif.). Revs. Modern Phys., 34: 267-86(Apr. 1962).

Anomalous and collisional diffusion of plasma particles across magnetic fields in arc chambers, positive columns, decaying plasmas, and strongly ionized plasmas is reviewed experimentally and theoretically. Micro- and macroscopic theories of anomalous diffusion are summarized. The conclusions reached are as follows: in arc plasmas, the ion diffusion coefficient depends on $1/B_z^2$; the screw instability is operative in positive columns; and only classical diffusion occurs if no electric currents are present. (T.F.H.)

13657 ON THE THERMAL CONDUCTIVITY OF PLASMA. V. S. Imshennik. Soviet Astron. AJ (English Transl.), 5: 495-7(Jan.-Feb. 1962).

The thermal conductivity coefficient of a plasma was computed in a second approximation by the Chapman-Enskog method for various arbitrary assignments of ion mass and charge. It is shown that the first approximation used by Chapman is extremely inaccurate quantitatively speaking. The convergence of successive approximations in the Chapman-Enskog method is discussed. At large

values of Z (Ze is the charge on an ion), the familiar Lorentz approximation is used for this purpose. (auth)

13658 ON THE PROPAGATION OF LOW-FREQUENCY OSCILLATIONS ALONG THE MAGNETIC FIELD IN A VISCOUS COMPRESSIBLE PLASMA. E. A. Ponomarev (Kiev State Univ.). Soviet Astron. AJ (English Transl.), 5: 673-7(Mar.-Apr. 1962).

The propagation along the magnetic field of low-frequency electromagnetic, transverse viscous and longitudinal oscillations in a plasma is considered. Relations are obtained which generalize the well known magnetohydrodynamic equations to the case of higher frequencies. The connection between the electric conductivity and viscosity is given. The energy exchange between different forms of waves is considered. Qualitative estimates applicable to conditions in the solar corona are made. (auth)

13659 EFFECTS OF MAGNETIC FIELD ON THE TEMPERATURE DISTRIBUTION IN COUETTE FLOW IN ANISOTROPIC MAGNETOHYDRODYNAMICS. V. B. Baranov. Zh. Prikl. Mekh. i Tekh. Fiz., No. 6, 8-12(Nov.-Dec. 1962). (In Russian)

The influence of anisotropic electric conductivity on the temperature distribution in Couette flow between parallel plates was studied using totally ionized and hypothetically incompressible gas. Two cases were discussed: one where the magnetic field is perpendicular to the plates and the other where the magnetic field is parallel to the plates, but perpendicular to the constant upper plate velocity. (R.V.J.)

13660 EFFECTS OF MAGNETIC VISCOSITY ON STABILITY OF PLASMA WITH ANISOTROPIC PRESSURE. G. M. Zaslavskii and S. S. Moiseev. Zh. Prikl. Mekh. i Tekh. Fiz., No. 6, 119-20(Nov.-Dec. 1962). (In Russian)

It was previously shown that a Larmor radius stabilizes heterogeneous plasma to groove instability. An attempt was made to find the Larmor radius considering the momentum transfer is related to the convolution of particles in a magnetic field and using hydrodynamic equations with specific magnetic viscosity tensors. The results indicated that even in a homogeneous plasma considerations of magnetic viscosity lead to the stabilization of plasma with anisotropic pressure. (R.V.J.)

13661 WAVE AMPLIFICATION IN A PLASMA STREAM IN A MEDIUM OF HIGH REFRACTIVE INDEX. P. C. Clemmow (Cavendish Lab., Cambridge, Eng.). Proc. Phys. Soc. (London), 80: 1322-32(Dec. 1962).

The problem is considered of an unbounded plasma stream with speed U traversing an infinite, homogeneous medium which has a fixed refractive index of arbitrary (real) value μ. The nature of the associated characteristic electromagnetic waves is studied, with particular reference to the existence of amplifying waves. It is shown that there is amplification if, and only if, $\mu > 1$; and that for a wave whose direction of propagation makes an angle α with the plasma stream, the amplification depends to some extent on whether U cos α is greater or less than c/μ, and is near optimum when U cos $\alpha = c/\mu$. The results of the analysis are related to the travelling-wave theory of the generation of very-low-frequency noise by fast charged particles streaming through the exosphere, and it is concluded that the mechanism in its simplest form cannot account for the arrival at the earth of discrete frequencies. (auth)

13662 THE ANALYSIS OF A VORTEX TYPE MAGNETOHYDRODYNAMIC INDUCTION GENERATOR. Lawrence Lajos Lengyel. Thesis, Cleveland, Cast Inst. of Tech., 1962. 140p.

Consideration is given to the performance characteristics of an a-c magnetohydrodynamic power generator. A rotating magnetic field is imposed on the vortex flow of an electrically conducting fluid, which is injected tangentially into an annulus formed by two nonconducting concentric cylinders and two nonconducting end plates. A perturbation technique is used to determine the two-dimensional velocity and three-dimensional electromagnetic field and current distributions. Finally, the generated power, ohmic losses, effective power, and electrical efficiency of the converter system are calculated. (Dissertation Abstr., 23: No. 6, Dec. 1962)

13663 AN INVESTIGATION OF NONLINEAR EFFECTS IN PLASMAS. Bruno Friedrich Ludovici. Thesis, Stanford, Calif., Stanford Univ., 1962. 152p.

A theoretical and experimental investigation of the phenomenon of spectral decay of propagating modes, which may manifest itself in the form of nonlinear mixing, cumulative traveling-wave interaction, and parametric amplification is presented as it relates to the so-called plasmaguide configuration. The plasma employed was furnished by the positive column of a low-pressure mercury vapor discharge. It was enclosed in an elongated glass tube surrounded by a slotted metallic sleeve. The nonlinear interaction was studied by means of a sampling probe, which moved along the waveguide slot. Experimental data and techniques for measuring attenuation, phase delay, and parametric effects are presented. Although the signal gains obtained are only marginal, as predicted by the theory, the presence of a significant idler gain is interpreted as experimental verification of the basic assumptions. The theoretical treatment is centered around a nonlinear, lossy, and dispersive transmission line analog of the plasmaguide. Normalized signal and idler gain curves are presented for various cases of attenuation and dispersion. This analysis is based on the assumption that the signal amplitude is small compared with the pump, and that the gain per unit wavelength is small. The analysis is not restricted to the case of the plasmaguide, but may be applied to any three hyphen frequency, continuous, traveling-wave parametric amplifier. (P.C.H.)

13664 ELECTRICAL GASEOUS DISCHARGES AND THERMOFUSION ELECTRICAL ENERGY. Thomas Xavier Lewis. British Patent 916,331. Jan. 23, 1963. Filed Apr. 29, 1958.

A means was provided to increase the temperature of gaseous discharges in toroidal tubes and to stabilize the gaseous discharges for longer periods. Thermofusion energy released in a toroidal tube can be directly converted into electric energy. (C.E.S.)

Shielding

13665 (CRRP-1127) BENDIX G-20 COMPUTER PROGRAMS FOR USE IN REACTOR SHIELD DESIGN. A. G. Fowler (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1962. 37p. (AECL-1678)

A series of six programs has been written for the Bendix G-20 computer to calculate the neutron and gamma ray attenuation in a multi-region shield of a power reactor. This report gives the basic theory on which the programs are based as well as the input and operating instructions for the programs. The dose rate in the outer region of a reactor shield is due almost entirely to capture gamma

rays produced locally. The thermal neutron flux, which is responsible for most of the capture gamma rays, is in general proportional to the number of fast neutrons slowed down in the immediate vicinity. Thus, to predict dose rate, it is essential to know the spatial and energy distribution of neutrons and gamma rays in the shield. The high-energy fission neutrons are treated using removal theory, and the slowing-down and thermal neutrons are treated using multi-group diffusion theory. The thermal neutrons produce capture gamma rays and the attenuation of these gammas is then calculated. (auth)

Theoretical Physics

13666 INVARIANT OPERATORS OF THE CASIMIR TYPE. L. C. Biedenharn (Duke Univ., Durham, N. C.). Phys. Letters, 3: 69-70(Dec. 1, 1962). (In English)

Results are reported on a group theoretical approach to nuclear spectroscopy. Representations of the unitary group in n dimensions are labeled uniquely by invariant operators, of which the Casimir invariant is the first. The operators are algebraically independent, and there are symmetric "vector coupling" coefficients that completely and explicitly solve the problem. Also each state belonging to a definite representation is designated by unique labels. (H.D.R.)

13667 FORMAL THEORY OF QUANTUM FLUCTUATIONS FROM A DRIVEN STATE. Melvin Lax (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 129: 2342-8 (Mar. 1, 1963).

A formal apparatus is developed for dealing with quantum fluctuations in a driven (nonequilibrium) state. Phenomenological equations for the decay of the system from an arbitrary state to the driven state are presumed known. By assuming that at some initial time the system-reservoir density matrix can be factored, we establish that the spectrum of fluctuations is given by the Fourier transform of the solution of the phenomenological equations, i.e., the regression of fluctuations obeys the "macroscopic" equations of motion even in the nonequilibrium case. (auth)

13668 REGGE SURFACES AND SINGULARITIES IN A RELATIVISTIC THEORY. J. Challifour and R. J. Eden (Cambridge Univ., Eng.). Phys. Rev., 129: 2349-53 (Mar. 1, 1963).

The analyticity properties of a partial wave amplitude a(l,s) are discussed in a relativistic theory. A domain of holomorphy in l exists when the full amplitude A(s,t) is bounded by a polynomial in t and satisfies the Mandelstam representation. The amplitude a(l,s) is unique provided it is required to satisfy the asymptotic conditions on l needed for Carlson's theorem. The types of singularity of a(l,s) are studied by tracing them along the Regge surfaces in (l,s) space on which they lie. We divide singularities into different classes that depend on the nature of the Regge surfaces. For one class inelastic (production) processes are unimportant, and we deduce that these singularities must be poles. Another class is related to the possibility of a Regge surface going into an inelastic unphysical sheet via the elastic unphysical sheet. It is shown that knowledge of this remote sheet is very important to the problem of establishing meromorphy domains of a(l,s). By means of unitarity and dominant Born terms we study the general form of the real sections of Regge surfaces with reference in particular to the occurrence of resonances. (auth)

13669 LOWER BOUND FOR THE LEADING REGGE TRAJECTORY. Peter G. O. Freund and Reinhard Oehme (Univ. of Chicago). Phys. Rev., 129: 2361-2(Mar. 1, 1963). (EFINS-62-62)

A lower bound is given for the high-energy limit of the invariant scattering amplitude F(s,t) which implies that $\lim_{t\to\infty}|F(s,t)| \geq O(t^{-1})$ for all values of the momentum transfer variable s. The derivation of this bound is based upon some general notions of dispersion theory. The situation in potential scattering is discussed briefly. (auth)

13670 SELF-CONSISTENT S MATRIX WITH REGGE ASYMPTOTIC BEHAVIOR. Geoffrey F. Chew (CERN, Geneva). Phys. Rev., 129: 2363-?(Mar. 1, 1963).

A general discussion is given of the formulation of self-consistent equations for two-body strong-interaction S matrix elements, on the assumption that all poles are of the Regge type and that asymptotic behavior is controlled by these poles. A tentative set of specific equations based on the strip approximation is presented and illustrated by a discussion of the $\pi\pi$ problem. In these equations Regge trajectories and residues for one channel are determined by the top-level Regge poles of the crossed channels. One parameter, the width of the strip, appears in the equations but it is argued that this parameter may oe fixed by the principle of maximum strength. (auth)

13671 SPIN 1/2 WAVE EQUATION IN DE-SITTER SPACE. F. Guersey and T. D. Lee (Middle East Technical Univ., Ankara and Columbia Univ., New York). Proc. Natl. Acad. Sci. U. S., 49: 179-86(Feb. 15, 1963).

Equations are given for the de-Sitter space, which can be represented by a 4-dimensional pseudo-sphere embedded in a 5-dimensional space. The physical consequences of invariance requirements under certain group transformations are examined by demanding that the field equations of elementary particles be invariant under the ten-parameter transformations in de-Sitter space. The examination is conducted by starting from an invariant Lagrangian, and the resulting equation differs in form from that obtained by Dirac, $\frac{1}{2}(\gamma^{\mu}\gamma^{\nu}L_{\mu\nu})\chi = R\lambda\chi$. The mass of the spin $\frac{1}{2}$ particle is determined only by the real part of λ: the imaginary part of λ has no direct physical meaning. (D.L.C.)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 12233, 12309, 12326, 12419, 12615, 12616, 12617, 12618, 12619, 12620, 12621, 12622, 12624, 12660, 12664, 12665, and 12716.

13672 (DP-815) HEAVY WATER MODERATED POWER REACTORS. Progress Report, December 1962. L. Isakoff and R. R. Hood, comps. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Jan. 1963. Contract AT(07-2)-1. 32p.

The Heavy Water Components Test Reactor (HWCTR) was operated intermittently for irradiation tests of fuel assemblies of various types. The U metal assembly that failed in the HWCTR in Nov. was removed to a spent fuel basin without difficulty. A one-week shutdown of the HWCTR was made for temporary repair of one of the steam generators to eliminate D_2O leakage through faulty tube sheet seal welds. Development was started on a fabrication process for coextruded driver fuel assemblies of the new two-tube design that is being considered for future use in the HWCTR. Fabrication was started on ten Zircaloy-clad tubes of U–350 ppm Fe–900 ppm Al for irradiation tests in the HWCTR; fabrication was completed on seven tubular assemblies of mechanical compacted uranium oxide, also scheduled for HWCTR tests. Preliminary evaluation tests were conducted on extruded joints of Zircaloy and stainless steel to obtain information on resistance to corrosion by water, and the effect of annealing on diffusion zone thickness and bond strength. (auth)

13673 (GAMD-3779) VIEW FACTORS FOR HEAT RADIATION IN HTGR CORE CONFIGURATION. J. A. Landoni (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Dec. 10, 1962. Contract AT(04-3)-314. 21p.

An analysis dealing with view factors is presented in an investigation of the overall interchange factors for heat radiation. Examples concerning the EGCR and the Peach Bottom Reactor are included. (J.R.D.)

13674 (GEAP-3885) EXPERIMENTAL FAST CERAMIC REACTOR DESIGN STATUS REPORT AS OF OCTOBER 31, 1961. K. M. Horst, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1962. Contract AT(04-3)-189. 109p.

The design status of the Experimental Fast Ceramic Reactor (EFCR) is described for the period up to October 31, 1961. The primary purpose of the facility is to study the dynamic behavior of a fast ceramic reactor, including the experimental demonstration of the effectiveness of the Doppler coefficient in limiting the power excursion following a rapid insertion of reactivity. The reactor chosen for this study has a power of 10 Mw(th) and is liquid metal cooled (NaK). The core has dimensions of approximately 2.5 ft H × 2.5 ft D and is fueled by a mixture of UO_2-PuO_2. The nuclear and temperature characteristics are like those of larger units designed for central station power plants. Results of the physics analysis and the design of the fuel elements, core assembly, control mechanisms, reactor vessel, and shielding are included. Also given is a description of the refueling system, coolant system, reactor building, and auxiliary equipment building. (auth)

13675 (GEAP-4001) HIGH POWER DENSITY DEVELOPMENT PROJECT. Seventh Quarterly Progress Report, October–December 1961. R. L. Holladay (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 1, 1962. Contract AT(04-3)-361. 64p.

The HPD fuel assemblies continued to accumulate exposure during the quarter. The average burnup for the various groups was 1770 to 2810 Mwd/t. Hot swaging of 10-mil stainless clad fuel rods to 95% theoretical density was demonstrated. Results of erosion tests on purposely defected swaged UO_2 rods of 90% T.D. indicate that these cladded types are highly resistant to UO_2 removal by coolant streams. Developmental work on fuel handling equipment and fuel assemblies for the Big Rock development is reported. Operation of a 9-rod heat transfer test section at mass velocities of 0.56×10^6 and 1.12×10^6 lb/hr-ft^2 for various qualities at 1000 psi is reported. Investigations in physics were aimed at developing economical methods of determining power distribution, the possibility of using axially distributed poison as a step toward improving axial power distribution, and development of a 300 Mw HPD conceptual design. Other activities are reported in coordination and test planning. (J.R.D.)

13676 (GEAP-4049) HIGH POWER DENSITY DEVELOPMENT PROJECT. Ninth Quarterly Progress Report, April–June 1962. R. L. Holladay (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1, 1962. Contract AT(04-3)-361. 49p.

The high power density fuel assembly average burnup reached 4,500 Mwd/t during the period. In a study of the performance in VBWR and the Big Rock Reactor of promising fuel assemblies efforts were devoted to two-pass swaged fuel rods, fuel specimen testing in the Trail Cable facility, two-pass swaged sintered UO_2 from ADU, and isostatic pressing of powder-compacted fuel rods. A summary of data from isostatic pressing experiments is included. Research on physics control of reactors is reported on power flattening during burnup with poison added to the central region of the core to reduce the axial peaking factor. Calculation results indicate that the addition of poison to the reaction will permit some increase in fuel enrichment. Completion of the computer scoping for the physics effort is reported. A simplified representation of the system is included. A code is being programed to calculate three-dimensional power distribution within a boiling water reactor. Information concerning coordination and test planning is included. (J.R.D.)

13677 (HPR-10) PHYSICAL MODEL, BASED ON BUBBLE DETACHMENT, AND CALCULATION OF STEAM VOIDAGE IN THE SUBCOOLED REGION OF A HEATED CHANNEL. R. W. Bowring (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Dec. 1962. 121p.

A physical model developed primarily for use in calculating the subcooled void distribution in the Halden Reactor at 5 to 30 atm. is described. The model is considered applicable to other systems with parameters in the following ranges. Pressure, 1 to 40 atm.; heat flux, up to 200 w/cm^2; and velocity, up to 200 cm/sec. (J.R.D.)

13678 (HW-75914) RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT. Quarterly Progress Report, July–September, 1962. M. M. Hendrickson and J. E. Brown,

eds. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1962. Contract AT(45-1)-1350. 139p.

Progress is reported in studies concerning Pu fuels, ceramic-U and metallic-Th fuels, physics, chemical research and development, analytical studies and advanced concepts, materials development, corrosion, heat transfer, radiation effects, gas-cooled reactor studies, instrumentation and nondestructive testing, and development of PRTR systems. (J.R.D.)

13679 (NAA-SR-6305) THE SNAP II POWER CONVERSION SYSTEM. ORBITAL FORCE FIELD BOILING AND CONDENSING EXPERIMENTS (OFFBACE). Topical Report No. 13. C. T. Jaenke, Alfred Koestel, and John G. Reitz (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Nov. 1961. For Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif. Contract [AT(11-1)-Gen-8]; Subcontract N843FS-101221. 153p. (ER-4670)

Boiling and condensing experiments under zero gravity conditions were conducted to investigate the operation of a mercury Rankine cycle power system similar to SNAP I and SNAP II designs. A detailed analysis of the phenomena involved in condensing under various gravity conditions is included. Empirical correlations based on mercury condenser pressure drop data were developed and further interfacial stability tests were made. (J.R.D.)

13680 (NAA-SR-7705) DETECTING AND ELIMINATING FUEL ROD BOWING IN THE SRE. R. W. Woodruff, C. W. Griffin, and R. W. Keaten (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1963. Contract AT(11-1)-Gen-8. 18p.

The second fuel loading of the Sodium Reactor Experiment was found to be unstable. The cause of the instability was traced to bowing of the individual fuel rods resulting in a fast positive power coefficient. Differential thermal expansion induced by a difference between fuel cladding temperatures on the outer and inner sides of the cluster caused bowing. Hydraulic bowing caused by differences in the flow velocities inside and outside the cluster was also observed. Fuel rod bowing, and hence the reactor instability, was eliminated by wrapping the fuel rods with stainless steel wire. Sustained oscillations in the flux were observed at constant power. These oscillations caused resonant peaks in the reactor transfer function as measured by pile oscillation and noise analysis techniques. The oscillations were caused by cycling of the fuel temperatures which produced an oscillatory bowing motion of the rods. Flux oscillations and resonant peaks were eliminated when the fuel was wire wrapped. (auth)

13681 (PRDC-TR-61) MONTHLY TECHNICAL REPORT [ON APDA ACTIVITIES] JULY 1962. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 16p.

Improvements in the offset handling mechanism are discussed along with seal materials for this mechanism. A literature search on sodium technology, particularly in the area of reactor material corrosion, revealed that corrosion is not likely to be a major problem at the Fermi Reactor. In other work, a review of materials for use in the Fermi Reactor was conducted. Results of an investigation of the primary shield tank heat transfer show that the temperatures at the top of the steel flex-legs vary from 715 to 740°F when the corrected values for heat generation are used. Physics investigations and development are reported on shielding, safety, reactor kinetics, and computer programs. Work in the area of mechanical design is reported on safety rods and hold-down repair. Systems development work was devoted to investigations of sodium hammer and a concrete water retention test are given. Test operations work included seal assembly testing, black cap test, graphite thermal conductivity tests, sodium corrosion tests, fuel subassembly bend testing, and rod drive mechanism testing. (J.R.D.)

13682 (TID-3574) REACTOR HOT CHANNEL FACTORS AND BURNOUT. A Literature Search. James M. Jacobs, comp. (Division of Technical Information Extension, AEC). Nov. 1962. 25p.

Results of a literature search on this subject are presented. Included are 184 references to report and published literature up to Oct. 1962, grouped according to the corporate author. (J.R.D.)

13683 (WAPD-BT-27) BETTIS TECHNICAL REVIEW. REACTOR TECHNOLOGY. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1962. Contract AT(11-1)-Gen-14 and appropriate NObs contracts. 97p.

Seven papers on reactor technology and related subjects are presented. Three have been abstracted previously in NSA; separate abstracts have been prepared for the remaining four. (D.C.W.)

13684 (WAPD-BT-27(p.1-19)) AN INVESTIGATION OF STABILITY IN A GLASS MODEL STEAM GENERATOR. E. J. McGowan and J. R. Bodoia (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

An investigation of self-induced flow oscillations in a glass model steam generator is described, and oscillation data are presented. The effects of the major controlling parameters on the stability of the model are discussed. In addition, the measured data are compared to the output of a digital computer program which computes the recirculation ratio and system stability in steam generators. The procedure followed, apparatus used, and data obtained are discussed. Input power level, downcomer subcooling, riser resistance, and downcomer resistance are the parameters examined. (D.C.W.)

13685 (WAPD-BT-27(p.21-36)) A COMPARISON OF COPRECIPITATION, COEVAPORATION, AND COMMINUTION PROCESSES FOR FABRICATING SINTERED ZIRCONIA–URANIA PLATES. J. C. Clayton, L. Berrin, and B. E. Schaner (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Comparison of sintering behavior and sintered-wafer characteristics obtained by wet methods with those gotten by dry mixing methods that introduce neutron-absorbing impurities is undertaken. Coprecipitation, coevaporation, and comminution procedures are used in preparing sinterable solid solution zirconia–urania powders of small particle size. Characteristics obtained by the various procedures are displayed. Coprecipitation yields highly sinterable powders, but warping is noted in high-density wafers. Coevaporation of mixed uranyl-zirconyl salt solutions produces a ZrO_2-UO_2 powder that can be fabricated into high-density plates. Highly sinterable mixed oxide powders can be obtained by milling calcined ZrO_2-UO_2 with alloy steel, alumina, and boron carbide grinding media. (D.C.W.)

13686 (WAPD-BT-27(p.53-7)) A SURFACE FINISH STANDARD FOR RADIOGRAPHING WELDS. J. F. Gipson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Surface finish requirements for welds in pipe and pressure vessels are not consistently and explicitly defined. An investigation is therefore undertaken to determine the

extent of surface conditioning of welds necessary for satisfactory radiography. As a result of a series of tests, it is concluded that a surface finish of 1000 μin. rms is adequate, provided that all welding code and material specifications are satisfied. (auth)

13687 (WAPD-BT-27(p.73-83)) CHIC NUMERICAL STUDIES FOR REACTOR THERMAL TRANSIENTS. G. Birkhoff, T. F. Kimes, and L. L. Lynn (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Several sets of difference equations for calculating the heat transfer from fuel plates in a single coolant channel of a nuclear reactor core are analyzed by numerical experiments performed by the three CHIC programs. The comparison of the results of simulating an underflow and an overpower transient indicate that the equations used in the Bettis MIM 01 program are the most accurate and most stable equations of all those investigated. (auth)

13688 (FTD-TT-62-1814) METHODS OF CALCULATING NUCLEAR REACTORS (SELECTED PARTS). G. I. Marchuk. Translation of p.2-17; 647-61 from "Metody Rascheta Yadernykh Reaktorov" (a publication of the State Publishing House of Literature in the Field of Atomic Science and Technology, Moscow, 1961). 44p.

Selected basic methods for use in reactor calculations are described. Included are algorithms for solving various problems originating during planning and development of atomic energy facilities. Calculated values of reactor critical masses are included. A bibliography of 318 entries is included. (J.R.D.)

13689 A NEW CRITERION REGARDING THE STABILITY OF SYSTEMS CONTAINING NUCLEAR REACTORS. V. M. Popov. Acad. Rep. Populare Romine, Studii Cercetari Energet. Ser. A, 12: 513-31(1962). (In Rumanian)

A stability criterion for the stationary state of physical systems containing nuclear reactors is set forth. The criterion is valid for initial conditions within a given domain. If this domain tends toward the stationary state of the system, the presented criterion tends toward the known criteria of first approximation, obtained by linearization. If the domain comprises all the initial conditions admitted, the criterion leads to a generalization of the Welton-Smets criterion. The results were obtained by extending a method previously established and applied to the study of the stability of non-linear systems. (auth)

13690 ACCUMULATION OF TECHNETIUM IN THERMAL REACTORS. B. S. Kir'yanov, A. P. Smirnov-Averin, and V. I. Galkov. At. Energ. (USSR), 13: 595-7(Dec. 1962). (In Russian)

During the determination of the isotopic composition of spent fuel elements of the First Soviet Atomic Power Station, Tc^{99} was separated in weighable amounts. The accumulation of Tc in the fuel elements was due to direct fissioning of U^{235} and indirectly from the Pu^{239} and Pu^{241} isotopes formed during the operation of the reactor. The amount of Tc formed from Mo does not exceed 1% and may be neglected. A formula was derived for calculating the amount of Tc accumulated in the reactor from either the integral flux or the burnup, assuming that the yield from Pu (5.9%) was the same as from U^{235} (6.06%). The Tc^{99} was identified by chemical, spectral, and mass-spectrographic methods. The Curie graph indicated that the isotope emits 0.29-Mev β-particles. The thin metallic Tc coatings needed for the measurements were prepared by reducing the NH_4 pertechnate in a H_2 stream at 500 to 600°C. (TTT)

13691 NUCLEAR FUEL AND POISON BURNUP NOMOGRAPHS. Irwin Drangel (General Electric Co., Schenectady, N. Y.). Atomics, 16: 24-5(Jan.-Feb. 1963). (TID-16171)

A mathematical function to closely approximate the variation of the self-shielding factor as a function of burnup was developed, which gives the depletion as a function of only the original self-shielding factor, the cross section, and the total incident neutron exposure. This equation was used to prepare a nomograph that allows calculation of depletions up to 98% with original self-shielding factors of 0.09 to 1. (M.C.G.)

13692 STEAM GENERATING REACTORS OPERATING IN FOG FLOW CONDITIONS. M. Silvestri (CISE, Milan). Energia Nucl. (Milan), 10: 39-42(Jan. 1963). (In English)

Steam-generating reactors are a wide class of reactors of which boiling-water reactors are just an example. By proper selection of flowrates and heated channel characteristics most of the steam generating portion in the core can be operated in annular-dispersed flow. This flow pattern has some peculiar aspects, which require a change in the usual approach in the design of the heated channels. (auth)

13693 A SURVEY OF THE PLUTONIUM UTILIZATION IN THERMAL AND FAST REACTORS. Jitsuya Hirota (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 4: 878-90(Dec. 1962). (In Japanese)

The Plutonium Recycle and Fast Reactor Programs in the U. S. are reviewed. Radiophysical and nuclear data, reactor physics, and estimated values of plutonium in thermal and fast reactors are included. The technical and economical feasibility of plutonium recycle in thermal reactors, especially in light water reactors, is to be established by 1970. A competitive fast reactor fueled with plutonium is also expected to be built around 1975. It is worthwhile to notice the "dual economy" of light water reactors and fast reactors. (auth)

13694 THE INSTRUMENTATION AND CONTROL CIRCUITS OF NUCLEAR REACTORS. E. H. Cooke-Yarborough (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Proc. I.R.E. (Inst. Radio Engrs.), 50: 1261-6(May 1962). (AERE-M-1108)

The chain reaction which takes place in a nuclear reactor is a regenerative process and can therefore be unstable, so the fission rate must be closely controlled in order that the nuclear reaction may proceed at a rate which is both useful and safe. Electronic circuits play a vital part in this, and their reliability must be exceedingly high, as many reactors are required to run for months without interruption and for years without an unscheduled shutdown. The dynamic behavior of a reactor and the circuit requirements associated with maintaining the power level constant is considered in a very elementary way. The additional problems associated with starting-up and the automatic shutting-down of a reactor are briefly surveyed and the use of automatic data-handling is considered. It is concluded that not all instrumentation and control problems presented by existing types of reactor have been satisfactorily solved and that more advanced reactors will present still more difficult problems. (auth)

13695 NUCLEAR REACTOR PLANT KINETICS AND CONTROL. M. A. Schultz and J. N. Grace (Westinghouse Electric Corp., Pittsburgh). Proc. I.R.E. (Inst. Radio Engrs.), 50: 1276-84(May 1962).

The successful application of frequency response and analog simulation techniques to reactor kinetics problems, together with experimental confirmation, has allowed increased dependence on inherent feedback mechanisms for

self-regulation and self-protection. Digital techniques are becoming increasingly important in transient analysis and in automation of reactor systems. Modern large reactors employing boiling coolant and/or natural circulation require thorough study of reactivity feedback, hydrodynamic effects, and spatial stability of the power distribution to assure successful performance. Many important areas exist for future analytical and experimental research, including prompt feedback mechanisms during fast excursions, stochastic fluctuations, reactor noise, and nuclear-thermal-hydraulic interactions. (auth)

13696 CONTROL AND REGULATION AT THE CHINON CENTER. Dardare and Lyon (Electricité de France, [Paris]). Rev. Gen. Electron., 16: 29-36(Nov. 1962). (In French)

A review is presented of the problems of control of the installations, regulation, automation, and treatment of information as well as prospects for the future. Emphasis is placed on the role of electronics. (D.L.C.)

13697 RESONANCE ABSORPTION OF NEUTRONS IN HETEROGENEOUS REACTOR. T. V. Golashvili. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 41-50(1962). (In Russian)

The general expression of the effective resonance integral for a heterogeneous system is obtained when Doppler broadening is taken into account. The one level formula of Breit-Wigner with the parameters E_0, Γ_n, Γ_γ was used in calculations and it was assumed that the mean logarithmic energy loss of a neutron ξE exceeds the width of the dangerous zone of the resonance absorption. (auth)

13698 INDIUM-GALLIUM IRRADIATION LOOP OF THE REACTOR IRT. A. Kh. Breger, Yu. S. Ryabukhin, S. G. Tulkes, and E. N. Volkov. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 51-8(1962). (In Russian)

The scheme, calculations, and technological characteristics of an indium-gallium loop are given. In such a loop containing 3 liters of the alloy an activity of 50,000 gram-equiv of radium is realized at a specific activity of the alloy of about 30 gram-equiv cm^{-3}. (auth)

13699 ON "RADIATION" NUCLEAR REACTOR. Yu. S. Ryabukhin and A. Kh. Breger. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 59-62(1962). (In Russian)

There are general considerations and results of estimations given that show the expediency of working out a special radiation reactor where indium-gallium may be used as a heat transfer agent. This alloy is at the same time a powerful source of γ radiation. (auth)

13700 INTRODUCTION TO STRUCTURAL PROBLEMS IN NUCLEAR REACTOR ENGINEERING. J. R. Rydzewski, ed. A Pergamon Press Book. International Series of Monographs on Nuclear Energy. Division VII: Reactor Engineering. Volume 2. New York, The MacMillan Company, 1962. 417p.

Included in the book are chapters entitled: An Introduction to Nuclear Reactors; Materials in Nuclear Reactor Construction; The Construction of Pressure Vessels in Mild Steel; The Linear Elastic Analysis of Statically Indeterminate Structures; The Use of Computers in Structural Problems; An Introduction to the Elastic Behaviour of Shells and Plates; The Matrix Progression Method in Structural Analysis; Thermal Stresses; The Plasticity and Creep of Metals; The Direct Design of Grillages; Reactor Pressure Vessels Analysis; Gas Duct Flexibility Analysis; and Application of Experimental Stress Analysis. There is an appendix on Concrete Pressure Vessels. The chapters are abstracted separately in NSA. In the appendix, the prestressed concrete pressure vessels at Marcoule and the Simon-Carves experimental pressure vessel are described, and the problems involved in the design of concrete pressure vessels are discussed. (M.P.G.)

13701 AN INTRODUCTION TO NUCLEAR REACTORS. R. W. Page. p.1-22 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

Atomic structure and types of nuclear reactions are briefly reviewed. The basic physical processes occurring in a reactor and the principles of a self-sustaining neutron chain reaction are described. The application of basic principles to the design and construction of power reactor systems is discussed, citing as examples the graphite-moderated gas-cooled reactor, the pressurized-water reactor, and the fast reactor. Diagrams and characteristics of specific reactors of each type in the United Kingdom are presented. Mention is also made of nuclear reactor safety and its importance in the structural design of any reactor. (M.P.G.)

13702 MATERIALS IN NUCLEAR REACTOR CONSTRUCTION. G. H. Broomfield. p.23-48 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The mechanisms resulting in changes in properties of materials due to nuclear radiation are explained. The effects of radiation on the tensile properties, notch ductility, creep properties, and fatigue of metals used in pressure containers and on reactor core materials, canning materials, graphite, liquid metal coolants, and container materials are described. (M.P.G.)

13703 THE CONSTRUCTION OF PRESSURE VESSELS IN MILD STEEL. D. F. T. Roberts. p.49-76 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

Topics pertinent to the design and manufacture of mild steel pressure vessels are discussed, including neutron irradiation of steels, brittle fracture, design requirements, nuclear and fuel canning factors, and selection of mild steel supply. The effects of forming and welding on plate properties are described, and the selection of weld metal, types of welds, and welding technique are considered in some detail. Methods of construction and inspection are also described. (M.P.G.)

13704 THE LINEAR ELASTIC ANALYSIS OF STATICALLY INDETERMINATE STRUCTURES. P. B. Morice. p.77-97 of "Introduction to Structural Problems in Nuclear Reactor Engineering. New York, The MacMillan Company, 1962.

The two fundamental methods of structural analysis, the stiffness method and the flexibility method, are compared. The linear elastic behavior of frames is analyzed by the flexibility method. A numerical procedure for computation of the equation obtained in the analysis is described, and a computer program is presented. An unsymmetrical fixed-foot portal frame is considered as an example. (M.P.G.)

13705 THE USE OF COMPUTERS IN STRUCTURAL PROBLEMS. E. A. Richards. p.99-124 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

Analog computers are briefly described, and digital computers are discussed in more detail, including binary notation, storage devices, and programming facilities. As an example, the analysis of forces and deflections of a rigid frame is performed with the use of a digital computer. Future possibilities for computers are discussed briefly. (M.P.G.)

13706 AN INTRODUCTION TO THE ELASTIC BEHAVIOUR OF SHELLS AND PLATES. A. H. Chilver. p.125-88 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The linear-elastic theory of thin shells is reviewed, and the forms this theory takes for spherical and circular cylindrical shells and membrane shells are also discussed. Flat plates are treated as an extreme case of shells. The buckling of shells and plates is considered briefly. (M.P.G.)

13707 THE MATRIX PROGRESSION METHOD IN STRUCTURAL ANALYSIS. H. Tottenham. p.189-210 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The "matrix progression method" is especially designed for analysis of complex structures composed of several shell or plate elements. The essential features of the method are outlined in the analysis of a simple, two-span beam with uniformly distributed load. (M.P.G.)

13708 THERMAL STRESSES. J. S. Przemieniecki. p.211-57 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The fundamental principles of thermoelasticity are presented. Typical methods of solving thermal stress problems in plates and shells subjected to "temperature loading" are described. Loss of stiffness caused by thermal stresses, thermal buckling, and methods of alleviating thermal stresses are also discussed. (M.P.G.)

13709 THE PLASTICITY AND CREEP OF METALS. J. M. Alexander. p.259-95 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The theory of plasticity and creep is treated from the engineer's viewpoint. The laws and equations of plasticity theory are compared to those in elasticity. The theory of the slip line field and limit analysis are discussed. Specific attention is paid to thermal and irradiation creep buckling. The discussion is limited to the behavior of a general three-dimensional continuum, and tensor notation is not used. (M.P.G.)

13710 THE DIRECT DESIGN OF GRILLAGES. N. W. Murray. p.297-320 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

Several types of grillages, the core support within the pressure vessel of a graphite-moderated reactor, are described. Two methods of direct design of "egg box" grillages with uniform boundary reaction are presented. The first method treats the load distributions and inertia ratios as the unknowns, resulting in non-linear simultaneous equations. In the second method, it is shown that if the loads are distributed equally between the x- and y-beams, the boundary reaction will be uniformly distributed. Deflections are matched at each intersection by varying the inertia ratios. There are no simultaneous equations to be solved in the second method. (M.P.G.)

13711 REACTOR PRESSURE VESSEL ANALYSIS. R. W. Bailey. p.321-33 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

Stresses are analyzed for a spherical pressure vessel with inner and outer cylindrical skirts of the same diameter. Stresses are calculated at the support region, considering the effects of internal pressure, axial load on skirts, self weight of vessel, and the external load on the vessel. Thermal stresses in the outer skirt are also calculated. (M.P.G.)

13712 GAS DUCT FLEXIBILITY ANALYSIS. J. F. Poynor. p.335-67 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The forces and moments set up in the large-diameter ducts which run between the reactor pressure vessel and the steam-raising units are evaluated for two basic systems: the hinged-joint system, which incorporates hinged-bellows units to absorb the thermal expansion; and the inherently flexible system, where all expansions are absorbed by deflection of the duct work in bends. Stresses in the reactor pressure vessel adjacent to the duct opening and acceptance limits for the calculated stresses are also considered. An analysis of creep in single plane duct systems is presented. (M.P.G.)

13713 APPLICATION OF EXPERIMENTAL STRESS ANALYSIS. J. R. Rydzewski. p.369-96 of "Introduction to Structural Problems in Nuclear Reactor Engineering." New York, The MacMillan Company, 1962.

The fundamental principles of model analysis are surveyed. Dimensional analysis, the only systematic method of investigating the relation between model and prototype, is treated in some detail. The variables that enter into the problem of an elastic structure subjected to static, dynamic, and thermal effects are listed, and the relation between model and prototype is discussed for the case of a statically loaded structure. Stress-strain relations in two dimensions are summarized, and methods of strain measurement are discussed. Photoelasticity and its use in stress analysis are also considered. (M.P.G.)

13714 DETERMINATION OF REACTOR SYSTEM PARAMETERS FROM CONTINUOUS OPERATING DATA. Donald Earl Rathbone. Thesis, Pittsburgh, Univ. of Pittsburgh, 1962. 99p.

A general method was developed that theoretically will permit the determination of a reactor system's parameters from the continuous operating data of the system. The only measurements required are those of three correlation functions, two cross correlation functions, and one autocorrelation function. The natural mode of operation for the control rods is used for the input function. A mathematical model of the system is required in the final step of the parameter evaluation technique. Each step in the overall approach is computer-oriented so that the complete solution can be programmed for a digital computer. Experimental verification of the method has not been made. It is anticipated that the practical implementation of the method will have many problems, one of which is the accurate determination of the transfer functions' coefficients from limited and inaccurate frequency response data. The results thus far consist of the development of the method and the investigation of some of the practical aspects of the techniques involved. (P.C.H.)

13715 FUEL HANDLING IN VERTICAL REACTORS. F. J. Libert and A. Virnot (INDATOM, Paris). Preprint S5-13. Prepublication Copy. 27p.

The development of equipment for fuel-element transfer and handling in the EDF-2 reactor and other gas-cooled reactors is described. A pneumatic connector between the reactor vessel and the fuel handling flask, a fuel-element charge-discharge machine, and a fuel-element manipulator are described and illustrated. Tests performed on static elastomeric seals, screw-nut assemblies, bearing grooves, manipulation cables, and sliding joints are also described. (M.P.G.)

13716 FUEL HANDLING IN THE G2 AND G3 MARCOULE'S NUCLEAR REACTORS. André Pages (Groupement des Constructeurs Francais de Centrales Nucleaires, [France]). Preprint S5-12. Prepublication Copy. 11p.

The G-2 and G-3 reactors have 1200 horizontal channels with 28 fuel elements in each channel. With continuous operation, the fuel handling equipment can load and unload about 35 channels a day without power decrease. New fuel cartridges are introduced into the reactor by a "loading lock chamber" machine mounted on a travelling crane. The machine, coupled to the channel to be loaded, equalizes the pressure in the lock chamber and channel, and pushes the fuel cartridges into the channel, thereby ejecting the irradiated cartridges from the other end of the channel. The operation of the loading machine and the handling of the spent fuel cartridges are described in detail. (M.P.G.)

13717 GRAPHITE STACKS. R. Martin (Commissariat à l'Énergie Atomique, [France]). Preprint S5-10. Prepublication Copy. 10p.

Research to improve the design of graphite stacks is reported. The design, construction, and testing of a vertical stack composed of hexagonal graphite prismatic blocks are described. A "lacunar stack" core assembly is also being studied. In this assembly, unbored blocks are used exclusively, channels being formed by the absence of columns. The possibility of reversing the direction of gas flow in the reactor is being investigated, and the advantages of this and the lacunal stack are presented. The use of graphite for fuel-element support sleeves is discussed. (M.P.G.)

13718 THE FUEL CYCLE IN FRENCH GRAPHITE-GAS CONCEPTS OF REACTORS. Overall Aspects of Fuel Manufacture and General Economic Data. J. Pheline. Preprint S2-03. Prepublication Copy. 37p.

A general outline of French achievements in the field of nuclear fuel is traced by following the fuel cycle from mining to reprocessing. The concentration of low-grade ore, U refining, fuel-element manufacture, the use of fuels in reactors, and reprocessing of irradiated fuel are discussed, and flowsheets are presented for several of the operations. Mention is made of the possible uses of Pu in fast breeder reactors, by recycling in reactors, and "in situ" in reactors such as the French heavy-water design where U fuels are consumed at high burn-up rates. Approximate economic data are presented on the cost of materials, manufacturing cycles, and investments. (M.P.G.)

13719 REACTOR SAFETY AND SAFETY CRITERIA. T. Aoki (Japan Atomic Energy Research Inst., Tokyo). Preprint S6-P4. Prepublication Copy. 5p.

The special problems associated with obtaining a suitable site for a nuclear reactor in Japan are discussed, including density of population, contamination of rice and vegetables, and psychological anxiety about radiation injury. A fixed monitoring system for the Japanese site is described. It consists of a circle of 10 to 12 G-M detectors around a reactor to measure γ radiation from radioactive clouds. The sensitivity and advantages of the system are reported. The system is under construction and is expected to cost less than $100,000. (M.P.G.)

13720 THE PRESTRESSED CONCRETE PRESSURE VESSELS FOR THE G2 AND G3 AT THE MARCOULE ATOMIC CENTER, FRANCE. J. Bellier, J. Fabreguettes, and C. Laroche. Preprint S7-16. Prepublication Copy. 11p.

The G-2 and G-3 prestressed concrete pressure vessels are the first of their kind to be designed and built anywhere in the world. With them it is possible to raise the internal working pressure to more than double that in the steel pressure vessels. The construction of the pressure vessels and how they are prestressed are described and illustrated. Gas tightness can not be ensured by the concrete alone, and a skin plate is required to line the inside wall. (M.P.G.)

13721 PRESSURE VESSELS FOR NUCLEAR REACTOR PRESTRESSED BY RADIAL ACTION. [Conversy (Enterprises Campenon Bernard, Paris)]. Preprint S7-15. Prepublication Copy. 16p.

A new design is described for a cylindrical concrete pressure vessel with vertical axis, horizontally prestressed with circular reinforcement external to the concrete. The process of prestressing by radial action is described in detail, and the design of a pressure vessel to be constructed by this process is presented. A model of part of a pressure vessel and the tests performed upon it are described. Results of the tests are summarized and show that a large-scale permanent structure could be constructed by this method. (M.P.G.)

13722 FAST NEUTRON REACTORS. G. Vendryes. Preprint S8-19. Prepublication Copy. 21p.

The breeding characteristics of fast neutron reactors are reviewed, and combinations of fissile and fertile materials to obtain an optimum rate of regeneration are considered. Other characteristics of fast neutron reactors are analyzed with the object of determining whether low cost electrical power can be produced by these reactors. The choice of fuel is discussed in detail. It is shown that Pu is necessary as a fissile material and that there are many advantages to having the fertile material U^{238} intimately associated in the core with the Pu. The questions of achievable burn-up and power density are also considered. Na is recommended for the coolant, and its advantages are summarized. Stainless steel is considered to be adequate for the construction of the main structural assemblies. The main technological problems associated with fast reactors are discussed, and tentative economic forecasts are presented. It is predicted that fast neutron reactors are likely to offer a sound and economically competitive solution to the production of electricity within 15 years. (M.P.G.)

13723 NUCLEAR SAFETY. Volume 4, No. 2. William B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Dec. 1962. $0.55 (GPO) (domestic), $0.70 (GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

Eighteen papers of a review type are presented on topics related to the analysis and control of hazards associated with nuclear reactors, operations involving fissionable materials, and the products of nuclear fission. The papers are divided into sections dealing with general safety criteria, accident analysis, control and instrumentation, plant safety features, consequences of activity release, and current events. Separate abstracts were prepared for all the papers. (D.L.C.)

13724 REACTOR SAFETY INSTRUMENTATION. M. A. Schultz (Milletron, Inc., Irwin, Pa.). p.1-13 of "Nuclear Safety. Volume 4, No. 2."

A review is presented of the development of reactor safety instrumentation. The reliability of multiple-channel instrumentation is discussed, and various checking systems for extending reliability are reviewed. The influence of transistorization on circuit design and the future trends in safety system design (particularly digitalization) are discussed. (D.L.C.)

13725 ATOMIC ENERGY REGULATION BY STATES. W. L. Harwell, E. J. Glennon, and J. L. Smith. p.14-26 of "Nuclear Safety. Volume 4, No. 2."

A study was made of state laws and regulations on the receipt, use, transportation, and disposition of nuclear material. Workmen's compensation acts in connection with alleged radiation injuries were also considered. The information obtained on each state are tabulated and summarized. (D.L.C.)

13726 EMERGENCY ACTIONS IN RADIATION ACCIDENTS. D. M. Davis. p.26-9 of "Nuclear Safety. Volume 4, No. 2."

Several definitions of a radiation emergency are given, and several improvements that should be made in emergency procedures are outlined. The AEC experience in radiation accidents and its methods for coping with them are described. Personnel dosimetry, exposures of rescue teams, and radiation surveying of large areas are discussed. (D.L.C.)

13727 NUCLEAR MERCHANT SHIP SITE CRITERIA. William B. Cottrell. p.29-33 of "Nuclear Safety. Volume 4, No. 2."

The site criteria for stationary reactors were modified in order to apply for the mobile reactor of NS Savannah, and a criterion for total population exposure was adapted in lieu of the city distance criterion. The three zones around the ship reactor are described. The conditions for port entry and additional measures for initial operations are outlined. The problems and implications of the criteria are discussed. (D.L.C.)

13728 RADIATION EMBRITTLEMENT OF REACTOR VESSELS. J. J. DiNunno and A. B. Holt. p.34-47 of "Nuclear Safety. Volume 4, No. 2."

A review is presented on the effects of irradiation on pressure-vessel steels, on the results of a survey of 19 reactor vessels with respect to their anticipated neutron doses, and on the research programs in this field. (D.L.C.)

13729 ARGONNE TRANSIENT REACTOR TEST FACILITY. J. R. Weir, Jr. p.47-50 of "Nuclear Safety. Volume 4, No. 2."

The characteristics of TREAT and the meltdown and metal-water reaction experiments carried out in TREAT are described. The general behavior of fuel elements under transient conditions and the metal-water reactions are summarized. (D.L.C.)

13730 SPERT PROGRAM STATUS REPORT. E. G. Silver. p.50-5 of "Nuclear Safety. Volume 4, No. 2."

A review is presented of the SPERT program and the results obtained in 1961. SPERT-I, II, and III are reviewed in turn. It is concluded that, when boiling occurs, the reactivity compensating effect of void formation is dominant; when boiling does not occur, the effects of fuel plate expansion and moderator heating qualitatively explain the observed reactivity compensation. (D.L.C.)

13731 COMBUSTION OF REACTOR MATERIALS. Sigfred Peterson. p.55-62 of "Nuclear Safety. Volume 4, No. 2."

A review is presented of reports on combustion of reactor materials. Among the materials covered are graphite, fuel metals, and structural metals. (D.L.C.)

13732 DESIGN OF SAFETY SYSTEMS FOR NUCLEAR REACTORS. J. E. Binns. p.63-70 of "Nuclear Safety. Volume 4, No. 2." (BNL-5300)

A philosophy of reactor safety is outlined, and a few criteria and guide lines are laid down for the reactor designer. The requirements for an ideal safety system are outlined. (D.L.C.)

13733 EXPERIENCE WITH NRX AND NRU SAFETY SYSTEMS. C. S. Walker. p.70-2 of "Nuclear Safety. Volume 4, No. 2."

The design and maintenance of reactor safety systems for reduced probability of unsafe failure are discussed. In a comparison between the component failure rates in NRX and NRU, it was found that close grouping of the ion chambers in NRX resulted in fewer amplifier failures. The causes of reactor shutdowns produced by the safety systems are outlined, and it is suggested that use of common elements for both control and safety results in a less reliable safety system. The importance of adequate tests of reliability is emphasized. (D.L.C.)

13734 RADIOACTIVE PLANT MAINTENANCE. D. M. Shepherd. p.73-9 of "Nuclear Safety. Volume 4, No. 2."

A review is presented of practices in the maintenance of nuclear power plants and radiochemical plants. The plants for which practices are summarized are the Homogeneous Reactor Experiment No. 2, Molten Salt Reactor Experiment, Sodium Reactor Experiment, Liquid-Metal Fuel Reactor, and Vallecitos Boiling-Water Reactor. The maintenance philosophies of various radiochemical plants are tabulated. (D.L.C.)

13735 REACTOR COOLANT CLEANUP. C. D. Scott and R. R. Holcomb. p.79-83 of "Nuclear Safety. Volume 4, No. 2."

A review is presented for decontamination of reactor coolants of the gas and water types. The removal of particulate matter, radioactive gases, and nonradioactive impurity gases from gaseous coolants is considered. The coolants of the water type considered are pressurized water, boiling water, and heavy water. (D.L.C.)

13736 REMOVAL OF RADIOIODINE FROM GASES. W. E. Browning, Jr. p.83-90 of "Nuclear Safety. Volume 4, No. 2."

A review is presented of tests of the iodine removal efficiency of activated charcoal, silver-plated copper mesh, and other materials. The gases considered are air, steam–air, and CO_2 and He at high temperatures. (D.L.C.)

13737 THE AREA WITHIN GROUND-LEVEL DOSAGE ISOPLETHS. F. A. Gifford, Jr. p.91-2 of "Nuclear Safety. Volume 4, No. 2."

In order to calculate total population dosage in reactor safety analysis, the area inside ground-level isodose contours should be known. A graph is given which can be used directly to estimate the area inside a given concentration isopleth. Best-fit lines for the observational studies of atmospheric dispersion are also included in the graph. Nishiwaka's equations for the concentration isopleth areas are given. (D.L.C.)

13738 ENVIRONMENTAL CONTAMINATION AROUND NUCLEAR FACILITIES. C. J. Barton. p.92-6 of "Nuclear Safety. Volume 4, No. 2."

The results of environmental surveys around nuclear facilities are described briefly. Stack monitoring data on the amounts of radioactive materials being discharged to the atmosphere are not readily obtainable, but a table of information on gaseous effluent monitoring and control practices at several reactor sites is presented. Contamination around fuel processing plants is considered briefly. (D.L.C.)

13739 OPERATING PRACTICES IN CONTAMINATED-CLOTHING LAUNDRIES. F. E. Harrington. p.96-9 of "Nuclear Safety. Volume 4, No. 2."

Good practices common to all laundries for contaminated clothing are outlined. The specific practices at Hanford, Chalk River, NRTS, Savannah River, and ORNL are reviewed to show the variation in detail while following the common practices. (D.L.C.)

13740 SM-1—PRESSURIZED-WATER-REACTOR OPERATING EXPERIENCE. J. R. Coombe. p.100-2 of "Nuclear Safety. Volume 4, No. 2."

The SM-1 reactor is described briefly, and its operating history is discussed from the standpoint of reactor safety. The system malfunctions, radiation levels, and failed fuel element are discussed in some detail. (D.L.C.)

13741 ABNORMAL EVENTS IN OPERATION OF AE-6, WATER BOILER RESEARCH REACTOR. J. R. Engel. p.102-5 of "Nuclear Safety. Volume 4, No. 2."

Two separate incidents that occurred in the AE-6 Water Boiler Reactor are reviewed, and their causes and the remedial measures taken to prevent future recurrence are described. The first incident was a power excursion to 4.5 kw (normal operation is at 2 kw) on Dec. 20, 1958. The second incident was a release of fission product activity on March 25, 1959, during a pumpdown of the gas system with the reactor shut down. The first one was determined to be due to precipitation and resuspension of uranyl peroxide, while the second one was due to a leak in the pump valve. (D.L.C.)

13742 IMPROVEMENTS RELATING TO CONTROL MEANS FOR NUCLEAR REACTORS. George Camac (to A. E. I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 882,361. Nov. 15, 1961. Filed Nov. 14, 1958.

A means was provided for rapidly shutting down a reactor in the event of failure of normal control means and normal shutting down means. A reservoir containing neutron absorbent material in a form having fluid properties was located above the core. On the receipt of an operating signal the material would pass through a duct into the core of the reactor so as to cause shutdown. (C.E.S.)

13743 IMPROVEMENTS RELATING TO ELECTROMAGNETIC CLUTCH ASSEMBLIES. Arthur Eric Green and Peter Balmer (to Associated Electrical Industries Ltd.). British Patent 902,207. Aug. 1, 1962. Filed July 4, 1958.

An electromagnetic clutch assembly of a solenoid member and a ferromagnetic armature member is designed with means for indicating whether or not the solenoid is in contact with the armature. The means comprise a search coil wound on the yoke of the solenoid and positioned so that, when the armature is in contact with the solenoid, it completes a low-reluctance flux path for the search coil. An application of the clutch is in the control and safety system of a swimming pool reactor. (D.L.C.)

13744 IMPROVEMENTS IN AND RELATING TO METHODS AND MEANS FOR FEEDING MULTI-TUBE CONNECTIONS IN GAS-TIGHT MANNER THROUGH A PARTITION, WALL, OR THE LIKE. Brian Vernon Gaskell (to General Electric Co. Ltd.). British Patent 903,418. Aug. 15, 1962. Filed Dec. 11, 1959.

A method for feeding multi-tube connections through a wall is described which has particular application to the sealing of sampling tubes from fuel channels in a nuclear reactor. In this method, a sealing tube is provided for each through-tube, its diameter being greater than the overall diameter of the through-tube and its projections on either side of the hole being such as to permit adequate access for welding, e.g., by flexing the projections. Two applications of the method for a burst fuel element can-detecting system in a pressurized gas-cooled reactor are described. (D.L.C.)

13745 CONTROL RODS FOR NUCLEAR REACTORS. Francis Robert Bell (to De Havilland Engine Co., Ltd.). British Patent 915,807. Jan. 16, 1963. Filed June 1, 1959.

A means for controlling the control rod in emergency, when it is desired to shutdown the reactor with the shortest possible delay, is described. When the emergency occurs the control rod is allowed to drop freely under gravity from the control rod support tube into the bore in the reactor core. A normal shutdown is reached almost at the lowest rod position. In the shut-down position and also below it, the control rod had its full effect of reducing the level of activity in the core. When the shut-down position was reached, a brake came into action to decelerate the rod and reduce shock and the likelihood of damage. (C.E.S.)

13746 CONTROL IN NUCLEAR REACTORS. Francis Robert Bell (to De Havilland Engine Co. Ltd.). British Patent 915,808. Jan. 16, 1963. Filed July 9, 1959.

An arrangement was described for scramming a reactor in an emergency. Control rods were position adjusted by an electric motor and transmission. A locking system kept the control rods in position but was arranged to be released in an emergency to allow the rods to drop into their shutdown position. (C.E.S.)

13747 IMPROVEMENTS IN OR RELATING TO HETEROGENEOUS NUCLEAR REACTORS. Alan Henry Butler, Harry Albert Cox, and Raymond Hicks (to General Electric Co. Ltd.). British Patent 916,144. Jan. 23, 1963. Filed May 4, 1959.

A means for improving the supporting means for the core structure of a heterogeneous nuclear reactor was described. A form of restraint was provided that would be effective at operating temperatures of the core. (C.E.S.)

13748 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Ian Hugh Morrison, David William Williams, Trevor Eyton Jones, and Eric Arthur Crouch (to United Kingdom Atomic Energy Authority). British Patent 916,176. Jan. 23, 1963. Filed July 31, 1959.

A sheathing for nuclear fuel elements was described that will give an early warning of defect. The fission products had a very short path to travel and diffused into the coolant and reached the burst cartridge detection apparatus before they decayed. (C.E.S.)

13749 IMPROVEMENTS IN AND RELATING TO SHUTDOWN ARRANGEMENTS FOR NUCLEAR REACTORS. John Edward Hallett (to General Electric Co. Ltd.). British Patent 916,199. Jan. 23, 1963. Filed Sept. 23, 1960.

A shut-down arrangement was described for a nuclear reactor having a core containing channels of uniform cross section arranged to receive fluid or fluid-like neutron absorbing material for shutting down the reactor. (C.E.S.)

13750 IMPROVEMENTS IN OR RELATING TO CONTROL RODS FOR NUCLEAR REACTORS. David John Ingram (to General Electric Co. Ltd.). British Patent 916,201. Jan. 23, 1963. Filed July 8, 1958.

Control rods were described that allowed free movement in the passages even though the core became distorted. An improved energy absorbing device was provided for use with the control rods. (C.E.S.)

13751 AUTOMATIC EQUIPMENT FOR THE CONTROL OF A NUCLEAR REACTOR. Pavel Kovanic and Milan Kulba (to Zavody V. I. Lenina Plzen, Narodni Podnik). British Patent 916,222. Jan. 23, 1963. Priority date Feb. 18, 1958, Czechoslovakia.

Equipment for complete automatic control of a nuclear reactor at all stages of the operation was described. (C.E.S.)

13752 IMPROVEMENTS IN OR RELATING ON NUCLEAR REACTORS. (to Indatom). British Patent 916,227.

Jan. 23, 1963. Priority date Mar. 27, 1959 and Feb. 24, 1960, France.

An atomic reactor was described that contains gas under pressure and sealing means for loading and unloading. Means were provided to control the pressures on either side of the valve without any possibility of leakage to the exterior of the reactor. (C.E.S.)

13753 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR SERVICING MACHINES. Douglas Edward Anderson (to General Electric Co. Ltd.). British Patent 916,253. Jan. 23, 1963. Filed Sept. 1, 1960.

A reactor servicing machine was described that comprises a pressure vessel housing a magazine for the storage of fuel elements and a charge tube for transferring fuel elements to the servicing machine. The transfer tube had two operating positions for transferring fuel elements between the magazine and charge tube. (C.E.S.)

13754 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer, Donald Frederick Peake, and Norman Battle (to Rolls-Royce Ltd.). British Patent 916,324. Jan. 23, 1963. Filed Apr. 25, 1958.

A control system for a nuclear reactor was described. A system of tubes was vertically arranged within the moderator mass and filled with a moderating liquid. The tubes were open at their lower ends, and the liquid level was controlled by feeding gas at controlled pressure to the upper ends of the tubes. (C.E.S.)

13755 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer and Norman Battle (to Rolls-Royce Ltd.). British Patent 916,325. Jan. 23, 1963. Filed Aug. 6, 1958.

The construction of a fuel channel was described that enabled a material such as stainless steel to be used for the wall of the space accommodating the fuel elements. A fuel channel was comprised of a thin stainless steel tube surrounded by a concentric aluminum alloy tube, the space between being filled with an insulant gas at a pressure equal to the pressure within the inner tube. (C.E.S.)

13756 IMPROVEMENTS IN OR RELATING TO FUEL FEEDING ARRANGEMENTS FOR NUCLEAR REACTORS. Reuben George Sandy Skipper, James McNeillis, and Douglas Edward Anderson (to General Electric Co. Ltd.). British Patent 916,820. Jan. 30, 1963. Filed Feb. 27, 1959.

A fuel feeding arrangement was described for a nuclear reactor comprising a main enclosing vessel that contained a core of moderating material with a plurality of vertical fuel channels through which fluid medium passed for abstracting heat from fuel elements. A fuel handling means below the main enclosing vessel was adapted so that fuel medium was at a lower temperature at entry than the fluid medium entering adjacent channels. (C.E.S.)

13757 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer and Norman Battle (to Rolls-Royce Ltd.). British Patent 916,821. Jan. 30, 1963. Filed Feb. 9, 1959.

A nuclear reactor was described comprising a main casing for the moderator material and end structures secured in position on the casing by ties. The ties extended through the casing and were constituted by coolant-conveying tubes in which fuel rods were adapted to be inserted when the reactor was in use. (C.E.S.)

13758 IMPROVEMENTS IN OR RELATING TO SUPPORTS FOR ELEMENTS IN ATOMIC PILES OR REACTORS HAVING VERTICAL CHANNELS. Michel Aubert and Roland Roche (to Commissariat a l'Energie Atomique). British Patent 916,871. Jan. 30, 1963. Priority date Sept. 18, 1958, France.

A support for fuel elements in reactors having vertical channels was described. The support shell was capable of receiving and surrounding the element and had internal supporting surfaces. (C.E.S.)

13759 IMPROVEMENTS IN OR RELATING TO PRESSURISED GAS-COOLED REACTOR SERVICING AND/OR FUELLING ARRANGEMENTS. Ronald George Swan (to General Electric Co. Ltd.). British Patent 916,895. Jan. 30, 1963. Filed Sept. 15, 1960.

A servicing and/or fueling machine was provided for pressurized gas cooled reactors. An auxiliary pressure vessel that houses these mechanisms was attached to the main pressure vessel by means of a nozzle and sleeve arrangement that resulted in a gas-tight engagement. The auxiliary vessel housed a number of mechanisms mounted on a rotatable turret or turntable. (C.E.S.)

13760 IMPROVEMENTS IN OR RELATING TO SERVICING MECHANISM FOR GAS-COOLED NUCLEAR REACTORS. Alfred Edward Clauson (to General Electric Co. Ltd.). British Patent 916,980. Jan. 30, 1963. Filed Dec. 8, 1959.

A servicing mechanism for gas-cooled reactors was described. It enabled the end portion of the charge tube to have a number of different radial operating positions. The cam mechanism comprised an axially movable cam operating member and a radially movable follower member. The charge tube comprised a pair of telescopic portions. (C.E.S.)

13761 FUEL ELEMENT FOR A NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 917,461. Feb. 6, 1963. Priority date June 19, 1959, Germany.

A fuel element is designed of hollow form. The element comprises a tubular metallic casing sealed at both ends, a nonfissile ceramic tube within the casing, and fuel disposed between the casing and the tube. The tube is porous, and the cavity is filled with helium, so that fission product gases can escape into the cavity and helium penetrates the voids in the fuel to ensure good heat transfer. (D.L.C.)

13762 IMPROVEMENTS IN AND RELATING TO CONTROL ROD OPERATING MECHANISMS FOR USE IN NUCLEAR REACTORS. George Tolfree (to General Electric Co. Ltd.). British Patent 917,809. Feb. 6, 1963. Filed Nov. 27, 1959.

A compact drive mechanism is designed for moving a control rod in a horizontal direction in a marine reactor. The mechanism comprises a flexible driving chain, one end of which is connected to the control rod and the other end left free. The chain passes over a driving sprocket and is accommodated by a housing with guide channels for the operative and inoperative parts of the chain. (D.L.C.)

13763 IMPROVEMENTS IN OR RELATING TO METHODS OF TESTING APPLICABLE TO THE CONTROL OF NUCLEAR REACTORS. Frederick John Stubbs and Gilbert Northcott Walton (to United Kingdom Atomic Energy Authority). British Patent 917,937. Feb. 13, 1963. Filed Dec. 9, 1960.

The control apparatus consisted of a fuel element leak detector and means for suddenly reducing the rate of flow of coolant through the coolant channels thereby rapidly raising the temperature of fuel elements. This rapid temperature raise caused a transient burst of fission products

from any existing leaks in the fuel element sheaths into the coolant stream for detection. (C.E.S.)

13764 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. (to General Dynamics Corp.). British Patent 918,224. Feb. 13, 1963. Priority date June 8, 1960, United States.

A canned reactor fuel element is designed which has reduced tendency to elongate irreversibly when subjected to sudden power surges. The fuel body is tapered inwardly toward its ends so that it has a reduced cross section at its ends. A high-temperature lubricant, e.g., colloidal graphite, is provided between the fuel body and the can. (D.L.C.)

13765 IMPROVEMENTS IN OR RELATING TO THE DETECTION OF BURST JACKETS IN NUCLEAR REACTORS COOLED BY A PLURALITY OF GASEOUS STREAMS. Jean Goupil (to Commissariat a l'Energie Atomique). British Patent 918,536. Feb. 13, 1963. Priority date Apr. 26, 1958, France.

A burst slug detection device is designed in which several gas streams are directed one at a time to the same radiation detector by electrostatic switching. In this device, each stream is sampled by a pick-up tube connected with a decay chamber, and a polarizing electrode is disposed within the chamber for trapping positive radioactive ions. Means is provided for successively and cyclically grounding each of the electrodes to release the ions from the electrodes into the detector unit. (D.L.C.)

13766 IMPROVEMENTS IN METHODS AND DEVICES FOR THE AUTOMATIC MONITORING OF THE VARIATIONS OF A PHYSICAL MAGNITUDE AT A MULTIPLICITY OF DISTINCT POINTS AND IN PARTICULAR FOR DETECTING CAN LEAKS IN THE CHANNELS OF A HETEROGENEOUS NUCLEAR REACTOR. Etienne Picard (to Commissariat à l'Energie Atomique). British Patent 918,537. Feb. 13, 1963. Priority date Feb. 17, 1959, France.

A method is given for monitoring the coolant from a multiplicity of reactor channels by means of a single instrument. The method comprises operating switches to transmit successively and cyclically the mean value of the monitored quantity for each sub-group of channels to the instrument and changing the switch control program whenever a defect is detected in one sub-group by withdrawing that sub-group for separate monitoring. A device for carrying out the method is described. (D.L.C.)

13767 IMPROVEMENTS RELATING TO THERMAL NUCLEAR REACTORS. Kenneth Prince and Norman Prince (to United Kingdom Atomic Energy Authority). British Patent 918,644. Feb. 13, 1963. Filed Nov. 13, 1960.

A nuclear reactor moderator structure having solid moderator material and a supporting framework was described. A floor for the moderator material was provided by a grid with a layer of overlaid plates. The plates were positively located relative to the grid by sliding keying means directed radially from the plate centers. There were gaps separating the plate edges to allow differential thermal expansion movements between the grid and plates. (C.E.S.)

13768 CONTROL SYSTEM. R. H. Shannon and H. E. Williamson (to U. S. Atomic Energy Commission). U. S. Patent 3,061,533. Oct. 30, 1962.

A boiling water type nuclear reactor power system having improved means of control is described. These means include provisions for either heating the coolant-moderator prior to entry into the reactor or shunting the coolant-moderator around the heating means in response to the demand from the heat engine. These provisions are in addition to means for withdrawing the control rods from the reactor. (AEC)

13769 METHOD OF OPERATING AN EVAPORATIVELY COOLED NUCLEAR REACTOR. Walter Gene Camack and George Leppert (to Lockheed Aircraft Corp.). U. S. Patent 3,077,443. Feb. 12, 1963. Filed June 3, 1958.

A liquid-cooled reactor is designed whereby vapor is generated without ebullition on the fuel elements or pressurization. In the reactor, the fuel elements are submerged in a pool to a sufficient depth that an appreciable increase of saturation temperature occurs from the evaporating surface to the fuel elements owing to the pressure head. (D.L.C.)

13770 VARIABLE FUEL NEUTRONIC REACTOR. William A. Frederick (to Westinghouse Electric Corp.). U. S. Patent 3,077,445. Feb. 12, 1963. Filed Sept. 2, 1958.

A quasi-homogeneous reactor using a ThO_2-UO_2 slurry in D_2O is designed with means for starting up and shutting down the reactor. The means comprises an apparatus for filling the reactor with either a very dilute slurry or D_2O alone, and for increasing gradually the concentration to the desired operating concentration under controlled conditions so that large inputs of reactivity are avoided. (D.L.C.)

13771 SODIUM DEUTERIUM REACTOR. E. D. Oppenheimer and R. A. Weisberg (to U. S. Atomic Energy Commission). U. S. Patent 3,079,321. Feb. 26, 1963.

This patent relates to a barrier system for a sodium heavy water reactor capable of insuring absolute separation of the metal and water. Relatively cold D_2O moderator and reflector is contained in a calandria into which is immersed the fuel containing tubes. The fuel elements are cooled by the sodium which flows within the tubes and surrounds the fuel elements. The fuel containing tubes are surrounded by concentric barrier tubes forming annular spaces through which pass inert gases at substantially atmospheric pressure. Header rooms above and below the calandria are provided for supplying and withdrawing the sodium and inert gases in the calandria region. (AEC)

Power Reactors

13772 (AAEC/TM-171) THE EFFECT OF DEPARTURE FROM THE OPTIMUM OPERATING CONDITIONS ON THE PRODUCTION COST OF ELECTRICITY FROM GAS-COOLED NUCLEAR POWER PLANTS. Ian M. Binns and O. O. Pulley (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Dec. 1962. 12p.

The second partial differentials of the production cost equation are derived in a generalized and non-dimensional form, in order to determine the effect on production cost of electricity from a gas-cooled nuclear power plant of departure from optimum operating conditions. Fuel element surface temperatures up to 650°C, production costs up to 1d.(A)/kwh and reactor coolant temperature rises up to half the maximum surface temperature are included. The most significant parameter is the ratio of the reactor coolant temperature rise to maximum surface temperature which causes a maximum increase in production cost of 0.5% for a ±5.0% change in its value. (auth)

13773 (ACNP-62847) SM-1A CORE II ZERO POWER EXPERIMENT. L. D. Walthousen, T. M. Raby, and F. G. Moote (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.; Allis-Chalmers Mfg. Co. Nuclear Power Dept., Washington, D. C.; and Allis-Chalmers Mfg.

Co., Schenectady, N. Y.). Jan. 21, 1963. Contract AT(30-1)-2639. 54p.

Zero power experiments performed on SM-1A Core II included an element-by-element reactivity check of fuel elements and control rod absorber sections and an estimate of burnable poison (B^{10}) loading in the stationary fuel elements. SM-1A Core II control rod fuel elements have 4.8 g less U^{235} per element than in SM-1A Core I and Core II has approximately 6 g more burnable poison (B^{10}) than Core I. A core assembly test performed by the inverse multiplication approach to criticality led to the development of a safe and rapid on-site loading procedure. Critical rod bank positions as a function of fuel loading were determined along with a control rod bank calibration. Critical rod configurations for the fully loaded core demonstrated that two control rods could be fully withdrawn and a third partially withdrawn before the reactor would produce a self-sustaining reaction. Burnup calculations performed for the SM-1A Core II indicate that the best estimate of core life is 13.8 Mw-years. (auth)

13774 (AGN-TM-379) PROPOSED NYLON TIEDOWN SYSTEM FOR THE ML-1. J. S. Alcorn (Aerojet-General Nucleonics, San Ramon, Calif.). July 15, 1960. Contract AT(10-1)-880. 51p.

A nylon rope tiedown/shock isolation system for air transport of the ML-1 (a mobile, low power nuclear power plant) is recommended to ensure plant serviceability after an emergency landing. The customary chain tiedown system will meet the air transportability specifications for the system, but will not ensure plant serviceability after an 8 G emergency landing. In addition to providing the required tiedown restraint, the proposed tiedown system reduces shocks transmitted to the ML-1 packages from the airframe, reduces package shocks transmitted back into the airframe, and predictably distributes tiedown loads. These functions are realized primarily by interposing five foot nylon rope elements in series with the standard chain tiedowns. Extensive system and component testing has accompanied development of the system, whose response under an actual aircraft emergency landing is predicted by theoretical calculations. (auth)

13775 (BAW-1243) CONSOLIDATED NUCLEAR STEAM GENERATOR FOR MERCHANT SHIP APPLICATION. A Conceptual Design. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Aug. 1962. Contract AT(30-1)-2468. 374p.

A conceptual design is presented from which the generator could be built with minimum confirming research and development. Information is also included concerning alternate features that would be incorporated in a potential power plant as incentives for further development of a nuclear-powered merchant fleet. (J.R.D.)

13776 (DL-50) NUCLEAR ELECTRIC POWER—ONE OF THE GIANTS. W. Bennett Lewis (Atomic Energy of Canada Ltd., Chalk River, Ont.). June 1962. 11p. (AECL-1674)

A survey of power requirements and potentials for the next 40 years is presented. It is noted that U costs will remain low and a continuing supply is assured. Several types of reactors including natural-U heavy-water-moderated systems seem likely to meet the competition set by large-scale plants using conventional fuel. (J.R.D.)

13777 (DLCS-5001262) MONTHLY OPERATING REPORT, DECEMBER 1962. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 54p.

The Station remained shutdown throughout Dec. for refueling operation in which the most significant occurrence was the replacement of Seed 3 with new Seed 4 elements. All primary and secondary systems, following the completion of refueling operation, were successfully filled, vented, and leak tested. Inspection of the deaerator and the moisture separator revealed no major deficiencies. Specified water conditions were maintained in the component cooling water and in the primary water storage tank at all times during the month. The results of the steam drum and heat exchanger inspections conducted in Nov. are comparable to the previous inspection results. There was no evidence of corrosion in any of the steam drums. Personnel radiation dosages were higher than normal during the month owing to the refueling operations and work associated with modifications to the 1A reactor coolant pump volute. However, all dosages were within specified limits. Certain refueling activities produced high levels of contamination. There were 13 tests performed in December, six of which were completed; the remaining seven tests were still in progress at the end of the month. Fifteen test procedures, reports, and evaluations were also prepared and issued during the month. Installation of all Core 2 decontamination system valves and connections that are inaccessible during power operation was completed. The storing of Core 2 steam generator units was discontinued during the month. (auth)

13778 (IDO-16820(Vols.I&II)) EXPERIMENTAL ORGANIC COOLED REACTOR SAFETY ANALYSIS REPORT. VOLUMES I AND II. G. H. Hanson and F. K. Clements, eds. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Nov. 30, 1962. Contract AT(10-1)-205. 608p.

A description of the EOCR is presented in which safety and accident analyses are included. The EOCR is a 40-Mw facility designed and constructed to develop information in the field of organic reactor technology. Results of analyses show that the system is stable under normal conditions and that its instrumentation is able to detect departures from acceptable conditions and effect corrective measures before serious damage occurs. The information is presented in parts on engineering description, reactor physics and engineering, operations, hazards of organic coolants, nuclear safety analyses, postulated mechanical accidents, and supporting information. It is concluded that the EOCR can be operated safely at powers up to 40 Mw. (J.R.D.)

13779 (NAA-SR-5599) SRE REACTOR FUEL HANDLING EQUIPMENT. E. O. Dryer, E. L. Brown, and W. J. Freede (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1963. Contract AT(11-1)-Gen-8. 39p.

Operating experience at the Sodium Reactor Experiment (SRE) indicated the need for an improved fuel handling cask. In addition, a means was required to transport irradiated, spent fuel elements to disposal processing sites. A new fuel handling machine and a fuel transport cask were developed, tested, and placed in operation. Design characteristics and operating procedures concerning this equipment are discussed. (auth)

13780 (NP-12476) BODEGA BAY ATOMIC PARK. UNIT NUMBER 1. Exhibit C. Preliminary Hazards Summary Report, December 28, 1962. (Pacific Gas and Electric Co., San Francisco). 282p.

Technical information is presented to show that a proposed nuclear power unit can be constructed and operated at Bodega Bay, Calif. without undue risk to the health and safety of the public. The proposed reactor is a light water moderated and cooled, forced circulation, direct cycle unit with a nominal thermal output of 1008 Mw. Descriptions are

included of the site and its environs, the principal features of the proposed unit, and project safety features. (J.R.D.)

13781 (ORNL-3353) THE ORNL GCR-3, A 750-Mw(e) GAS-COOLED CLAD-FUEL REACTOR POWER PLANT. A JOINT DESIGN STUDY. (Oak Ridge National Lab., Tenn.; Tennessee Valley Authority, Oak Ridge, Tenn.; Tennessee Valley Authority, Knoxville, Tenn.; Westinghouse Electric Corp. Atomic Power Div., Pittsburgh; Westinghouse Electric Corp. Steam Div., Lester, Penna.; and Combustion Engineering, Inc. Nuclear Components Engineering Dept., Chattanooga). Feb. 4, 1963. Contract W-7405-eng-26. 386p.

An advanced, gas-cooled, clad-fuel reactor power plant to generate 750 Mw of electricity was designed as a study of the potential capability of that system. The graphite-moderated reactor generates 1908 Mw of heat in 1062 fuel channels 21 ft long for a power density of 5.5 kw/liter. Gas temperatures entering and leaving the reactor are 574 and 1150°F, respectively, operating at 420 psia. Steam at 2415 psia and 950°F with reheat to 1000°F drives a 763-Mw(e) turbogenerator and also four 31,000-hp blower drive turbines and the boiler feed pumps. Net thermal efficiency of the plant is 39.4%. Estimated direct cost of construction is $110,267,000, or $147 per kilowatt net electric output. Fuel-cycle costs at 20,000 Mwd per metric ton of uranium are 1.46 mills/kwhr, operating and maintenance costs are 0.39 mill, and fixed charges range from 1.80 to 4.65 mills, depending on method of financing. Total power generation costs at an 80% load factor range from 3.65 to 6.50 mills/kwhr. (auth)

13782 (WCAP-6050) ANALYSIS OF THE REACTIVITY CHARACTERISTICS OF YANKEE CORE I. C. G. Poncelet (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Jan. 1963. Contract AT(30-1)-3017. 139p.

The reactivity characteristics of the operating Yankee Core I are analyzed. Calculations of kinetic parameters, kinetic coefficients, control rod and boron worth, core lifetime and burnup rate, and fission product poisoning, are described. A large amount of experimental data obtained during Core I operation is included and comparisons are made between prediction and experiments. (auth)

13783 (WCAP-6051) POWER DENSITY AND BURNUP DISTRIBUTIONS IN YANKEE CORE I. J. D. McGaugh and R. H. Chastain (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Jan. 1963. Contract AT(30-1)-3017. 150p.

The results of measurements and calculations of power density and fuel burnup distributions in the first Yankee core are discussed. The description of a recent fuel depletion analysis of a portion of the core is also presented and a schedule of interchange of control rod groups is recommended. (auth)

13784 NUCLEAR POWER DEVELOPMENT IN CANADA. Atomics, 16: 6-18(Jan.-Feb. 1963).

The history and conditions surrounding Canada's nuclear energy program are reviewed. The organization of Atomic Energy of Canada Limited, Atomic Energy Control Board, and Eldorado Mining and Refining Limited is outlined. Chalk River activities and facilities are described along with construction of the Whiteshell Nuclear Research Establishment. The Canadian effort in nuclear power production is compared with that of other countries. The design and development of the NPD and CANDU reactors are described, and drawings and pictures presented. (M.C.G.)

13785 WATER SEPARATOR FOR WET-STEAM TURBINES IN ATOMIC POWER STATIONS. W. Vollmann and A. Kuhn. Brown Boveri Rev., 49: 341-9(July-Aug. 1962). (In English)

A water separator is described that has large contact surfaces and low pressure drop. Development tests in an air-water flow are reviewed. The results are confirmed in a steam turbine cycle. (auth)

13786 THE RAPTUS PROJECT. B. Ferretti, S. Barabaschi, G. Naschi, and F. Pierantoni (Comitato Nazionale per l'Energia Nucleare, Rome). Comit. Nazl. Energia Nucl., Notiziario, 8: 3-10(July 1962). (RT/GEN(62)2). (In Italian)

The Comitato Nazionale per l'Energia Nucleare, acting within the frame of the development of nuclear power plants in Italy, has undertaken some time ago a comparative study of different solutions, evaluating them from the following two points of view: (a) technical and economic features; (b) insertion into the present Italian research programme in relation to the domestic status of nuclear power and the integration of these programmes into the ones of the Community. It is on the basis of the above two points that due considerations have been given to the RAP.T.U.S. (Fast-Thorium-Uranium-Sodium) reactor. The latter combines the advantages offered by fast sodium cooled reactors of the O.R.E. type (homogeneous heterogeneously cooled). The idea at the basis of this reactor type is to reduce the cost of the fuel cycle until it reaches the level of homogeneous reactors, but avoiding all technical difficulties inherent to the latter. (auth)

13787 NUCLEAR POWER STATIONS. S. A. Skvortsov. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 15-23(1962). (In Russian)

The main directions along which atomic energy may develop are considered and different types of reactors used in nuclear power stations are described. (auth)

13788 COMPUTER SOLUTIONS TO NUCLEAR ICE-BREAKER PROPULSION PROBLEMS. George F. Rodgers (General Dynamics Corp., Groton, Conn.). Trans. Am. Inst. Elec. Engrs., Pt. II, 81: No. 59, 33-40(Mar. 1962).

The nature of the power requirements for icebreaker propulsion (i.e., high transient power, quick propeller reversals, etc.) is discussed. A digital-computer simulation of the operation of a nuclear power plant designed for icebreaker use is carried out. The variables involved and the control elements required are analyzed, with particular reference to the electromechanical section of the system. (T.F.H.)

13789 ATOMNYE ELEKTROSTANTSII. (Atomic Electric Power Plants). P. A. Petrov. Moscow, Gosenergoizdat, 1961. 142p.

A popular survey is given on the applications of nuclear power and on the construction of power reactors. Descriptions are given of power plants and nuclear fuels in USSR and abroad. (R.V.J.)

13790 THE PRESSURIZED WATER REACTOR WITH SPECTRAL SHIFT CONTROL. W. T. Moore (Babcock and Wilcox Co., New York). Preprint Paper No. 62-WA-239. New York, The American Society of Mechanical Engineers, 1962. 8p. $1.00.

Paper from Winter Annual Meeting, New York, Nov. 1962.

A description is given of a central station generating unit to supply 450 Mw (net) of electric power utilizing a pressurized-water reactor with spectral shift control. Based on 80 percent load factor and 14.5 percent fixed-charge rate, this plant will generate electricity at a cost between 5.5 and 6.0 mills per net kwh. (auth)

13791 LARGE NUCLEAR POWER PLANTS—THEIR COMMERCIAL AVAILABILITY, OPERATIONAL PRE-

DICTABILITY AND ECONOMICS. W. L. Budge and A. R. Jones (Westinghouse Electric Corp., Pittsburgh). Preprint Paper No. 62-WA-349. New York, The American Society of Mechanical Engineers, 1962. 5p. $1.00.

Paper from Winter Annual Meeting, New York, Nov. 1962.

Closed-cycle water reactors have been designed in ratings up to 750 megawatts electric. These designs are predicated on technology sufficiently in hand to allow immediate start of projects aimed at putting plants in operation in 1966. These plants are direct descendants of the highly successful Yankee Atomic Electric Company unit. Because of their basic similarity to the Yankee unit, both their technical and economic performances can be predicted with a high degree of reliability. (auth)

13792 THE AEC NUCLEAR SUPERHEAT PROGRAM. Claude A. Pursel (Chicago Operations Office, AEC, Argonne, Ill.). Preprint Paper No. 62-WA-311. New York, The American Society of Mechanical Engineers, 1962. 9p. $1.00.

Paper from Winter Annual Meeting, New York, Nov. 1962.

The AEC-sponsored Nuclear Superheat Program has been under way for three years. Participating organizations include three utility companies, three nuclear engineering firms, and one national laboratory. The goal of the program is to increase the thermal efficiency of the direct-cycle boiling-water-reactor concept by increasing the outlet steam temperature. The overall cost incentive, due to the increase in thermal efficiency alone, is about 1 mil/kwh. From this must be subtracted the economic penalties imposed by the problems of producing nuclear superheat in a water-cooled reactor. These problems are in the process of being identified through a basic research and development program and the construction and operation of four nuclear superheat reactors. The two major problems which are yet unresolved are a satisfactory fuel-cladding material for the nuclear superheat fuel elements and the magnitude and effects of the discharge of radioactive particles to the turbine and its auxiliaries. The four nuclear superheat reactors will be in operation in 1963. It is anticipated that by 1965 all operational, design, and fabrication problems will have been identified and engineering solutions will have been found. The net economic incentive of nuclear superheat as contrasted to the saturated steam-boiling water reactor is now estimated to be between 0.4 and 0.6 mil/kwh in the larger sizes. The upper limit for nuclear superheat reactors to be operational by 1970 is currently estimated to be approximately 1000 Mw(e). (auth)

13793 HEAVY WATER MODERATED CIVILIAN POWER EXPERIMENT. Carle (CEA, [Paris]). Preprint S8-20. Prepublication Copy. 39p.

The advantages of a heavy-water-moderated power reactor using CO_2 under pressure as coolant are discussed in detail. Fundamental technical problems are examined, including the design and fabrication of Zircaloy-2 pressure tubes, the thermal insulation between the water and the gas, and the design of the fuel elements. The construction and testing of the core tank are also discussed. The EL-4 reactor is described. The finished reactor is not expected to go critical before 1966. (M.P.G.)

13794 THE FRENCH ASSOCIATION OF NUCLEAR POWER PLANT MANUFACTURERS. M. Gibrat. Preprint S5-07. Prepublication Copy. 4p.

The Association was founded to promote the construction of nuclear power plants based on the French natural uranium design. Approximately 20 companies belong to the Association, the leading ones being ALSTHOM, G.A.A.A., INDATOM, and SFAC. The major assets of the Association are its wide scientific, technical, and technological experience, its huge industrial capacity, and its versatility of operation and management. Each of the assets are discussed. (M.P.G.)

13795 THE CHINON NUCLEAR POWER PLANT. P. Passerieux (Electricite de France, [Paris]). Preprint S2-02. Prepublication Copy. 65p.

The Chinon reactors, EDF-1, EDF-2, and EDF-3, are described in detail, including the design of the reactors, the cooling and steam-producing circuits, and the turbine-generators and auxiliaries. EDF-1 was designed for a thermal power of 300 Mw and a net electric power of 60 Mw. EDF-2 includes an 800 Mw thermal power reactor and two 125 Mw turbine generators, to supply ~170 Mw(e) net. It should be in operation at the beginning of 1964. The EDF-3 is composed of a 1,250 Mw reactor, which may be raised to 1,570 Mw, and two 250 Mw turbine generators, to supply a net electric power of 375 Mw, which may be increased to ~480 Mw. It should be operating in 1965. Pictures, diagrams, and data are presented for all of the plants. (M.P.G.)

13796 THE FRENCH NATURAL URANIUM, GAS-COOLED GRAPHITE POWER REACTOR PROGRAM. C. Leduc (Commissariat á l'Energie Atomique, [France]) and B. Saitcevsky. Preprint S2-01. Prepublication Copy. 10p.

A summary of the French program is presented. The rate of construction is set at 200 Mw(e)/year. Objectives and guiding principles are mentioned, and some distinctive features of the French reactor system are discussed, including hollow fuel elements, herring-bone canning, triangular lattices, flux flattening by varying the U-graphite ratio, and prestressed-concrete pressure vessels. A few examples of the research and testing involved in the reactor program are briefly mentioned. Basic data on the G-2, EDF-1, EDF-2, and EDF-3 reactors are presented in tabular form. (M.P.G.)

13797 SAFETY ASPECTS OF NUCLEAR POWER REACTOR IN JAPAN. T. Yoshioka (Japan Atomic Power Co.). Preprint S6-P3. Prepublication Copy. 5p.

Problems in selecting a reactor site in Japan are reviewed, and standards for site selection are listed. Since it is impossible in Japan to ensure safety by locating the reactor in an isolated area, stringent safety measures must be adopted. Special safety measures designed for the Tokai reactor are described, and permissible radiation doses are listed. The disposal of radioactive gaseous and effluent wastes is discussed, and the radiation monitoring system is described. (M.P.G.)

13798 REPORT ON THE CONTROL SYSTEM OF THE CHINON PLANT. Laurent and Fays. Preprint S6-P2. Prepublication Copy. 14p.

The control system of the Chinon Power Plant, including reactors EDF-1, EDF-2, and EDF-3, is described. The special characteristics of nuclear power plants and the automation requirements are reviewed. The aim of the Chinon power plant design was to make it as flexible as conventional plants. The design of regulation, measurement, and automation equipment for the EDF-1 reactor in order to achieve flexibility is described. Modifications of equipment for the EDF-2 and -3 reactors are also discussed. (M.P.G.)

13799 TURBINES FOR THE EDF1, EDF2, EDF3 NUCLEAR POWER STATION. G. Bertonazzi and G. Kauff-

mann (Société Générale de Constructions Electriques et Mécaniques ALSTHOM and Groupement des Constructeurs Francais de Centrales Nucléaires, [France]). Preprint S7-18. Prepublication Copy. 29p.

The main characteristics of the steam turbines for the Chinon power station are described. The electronic control systems for the EDF-2 and -3 turbines are also discussed. Pictures and diagrams of the turbines, steam cycles, and electronic controls are provided. (M.P.G.)

13800 UTILIZATION OF PRESTRESSED CONCRETE IN CAISSONS OF NUCLEAR POWER PLANTS. THE CAISSON OF THE E.D.F. 3 REACTOR. Preprint S7-17. Prepublication Copy. 10p.

The advantages of using a prestressed concrete pressure vessel for the EDF-3 reactor are discussed. The pressure vessel and the way in which it is prestressed are described. The requirements and assumptions on which the design calculations were based are presented, and tests on models and the results of the tests are reported. (M.P.G.)

13801 AN IMPROVED METHOD OF AND APPARATUS FOR GENERATING SUPERHEATED VAPOUR. Norman George Worley (to Babcock and Wilcox Ltd.). British Patent 903,012. Aug. 9, 1962. Filed Mar. 22, 1960.

A method for generating superheated vapor in a nuclear power plant is described. The method includes supplying feed liquid to a forced-flow, once-through vapor generating and superheating unit, circulating coolant in a closed circuit through the reactor and unit, controlling the heat output of the reactor to give a constant coolant temperature at the reactor outlet, and limiting movement of the transition zone. A plant for carrying out the method is described. (D.L.C.)

13802 A GRAPHITE MODERATED HETEROGENEOUS NUCLEAR REACTOR. (to RNB Corp.). British Patent 915,773. Jan. 16, 1963. Priority date Nov. 26, 1958, United States.

A reactor was described in which there was no possibility of fuel element failure, in the sense that the fuel and/or fission products can be entrained in the reactor coolant or otherwise contaminate the operating circuits, and wherein no circulating fluid coolant bathed the fuel or its immediate container. Undesirable radioactive fission products were removed from reactor fuel before they decayed to serious reactor poisons, thus improving the neutron economy and allowing much longer irradiation of fuel. All possible hazards were minimized in the construction of the reactor. (C.E.S.)

13803 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer (to Rolls-Royce Ltd.). British Patent 916,326. Jan. 23, 1963. Filed Nov. 5, 1959.

A nuclear reactor was described that possesses safety means to reduce the possibility of accidental increase in reactivity after permanent shutdown. The reactor illustrated was for marine purposes and of the steam-cooled heavy-water moderated type. (C.E.S.)

13804 IMPROVEMENTS IN OR RELATING TO PRESSURISED FLUID-COOLED NUCLEAR REACTORS. John Henry Wilson (to Simon-Carves Ltd. and General Electric Co. Ltd.). British Patent 917,606. Feb. 6, 1963. Filed Nov. 8, 1960.

The reactor core was housed within a concrete pressure vessel, and different regions of the inner surface of the pressure vessel were adapted to be cooled by coolant flowing in heat exchange relations with the surface in separate circuits independent of the main reactor coolant. (C.E.S.)

Production Reactors

13805 THE IMPORTANCE OF NUCLEAR PHYSICS PRINCIPLES FOR THE INTERPRETATION OF FAST BREEDER REACTORS. W. Haefele (Kernforschungszentrum, Karlsruhe, Ger.). Physik. Verhandl., Verband Deut. Physik. Ges., 2: 405-15(1962). (KFK-118). (In German)

The production of Pu^{239} from U^{238} in reactors is discussed along with the production of U^{233} from Th^{232}. The rates of production of these fissionable isotopes are also discussed as a basis for the breeder reactor concept. The possibility of the operation of a fast breeder reactor in a closed U^{238}-Pu^{239} cycle is reviewed. The resonance structure of the neutron absorption cross section for almost all elements is described. Criticality, dynamic stability, resonance processes, Doppler coefficient, and effective cross sections are discussed. (M.C.G.)

13806 MULTI-ZONE NATURAL-URANIUM REACTOR WITH GRAPHITE AND HEAVY WATER AS MODERATORS. (to Kurt Diebner). British Patent 916,893. Jan. 30, 1963. Priority date May 30, 1959, Germany.

A multi-zone reactor with natural uranium as a fuel was described. The zones were charged alternatively with heavy water and graphite as a moderator, the heavy water zones having an excess reactivity to ensure a supply of excess neutrons to the surrounding natural-uranium-graphite-zones and thus increased the specific power and improved U^{238} conversion. (C.E.S.)

Research Reactors

13807 (CNEN-131) COMPORTAMENTO DINAMICO DEL REATTORE TRIGA. I. MODELLO PER LA DESCRIZIONE DEL COMPORTAMENTO DINAMICO DEL REATTORE A POTENZA. (Dynamic Behavior of Triga Reactor. I. Model for the Description of the Dynamic Behavior of a Power Reactor). M. Perni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Fisica Nuclear Applicata, Rome). Sept. 1962. 56p.

A model of the kinetic behavior of the Triga reactor is presented. Results of an analog computer study were in agreement with those obtained in similar work at General Atomic Div. (J.R.D.)

13808 (CNEN-136) COMPORTAMENTO DINAMICO DEL REATTORE TRIGA. II. DETERMINAZIONE DELLA REATTIVITA INSERITA PER MEZZO DI MISURE DI PERIODO STABILE A BASSA POTENZA. (Dynamic Behavior of Triga Reactor. II. Determination of the In-Pile Reactivity by Means of Measuring the Steady Period at Low Power). M. Perni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Fisica Nuclear Applicata, Rome). Sept. 1962. 53p.

Calculations on the Triga reactor reactivity as a function of the steady period were performed by means of the inhour equation. The deviations of the period remarked experimentally from the theoretical one and the waiting time for the observation of the experimental period were fixed. (auth)

13809 (CNEN-137) COMPORTAMENTO DINAMICO DEL REATTORE TRIGA. III. OSCILLAZIONI FORZATE A BASSA POTENZA. (Dynamic Behavior of Triga Reactor. III. Induced Oscillation at Low Power). M. Perni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Fisica Nuclear Applicata, Rome). Sept. 1962. 45p.

The oscillations of the Triga reactor induced by a

sinusoidal reactivity were studied. In order to get fixed oscillations, the input of the reactivity must be expressed by $\delta k^* + \delta k_\beta + \delta k_f \sin \omega t$ where δk_f is negative and function of δk_f and ω. Since the reactors are nonlinear systems, in the answer P(t) there are harmonics. The calculations were performed on the IBM 650. (auth)

13810 (CNEN-138) COMPORTAMENTO DINAMICO DEL REATTORE TRIGA. IV. BURSTS DI POTENZA SECONDO I MODELLI DI FUCHS, FORBES, CORBEN. CONSIDERAZIONI SULLA SICUREZZA. (Dynamic Behavior of Triga Reactor. IV. Power Bursts According to the Fuchs, Forbes, and Corben Models. Safety Considerations). G. Focaccia and M. Perni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Fisica Nuclear Applicata, Rome). Sept. 1962. 35p.

The characteristic parameters of the power bursts were examined using the Fuchs, Forbes, and Corben models. The results were compared with those obtained at General Atomic Div. It was found that under the worst safety conditions the burst energy can be absorbed with no damage. (J.R.D.)

13811 (CNEN-139) COMPORTAMENTO DINAMICO DEL REATTORE TRIGA. V. VALUTAZIONE PRELIMINARE DELL'ACCESSO DI REATTIVITA INIZIALE PER MAGGIORI LIVELLI DI POTENZA DI REGIME. (Dynamic Behavior of Triga Reactor. V. Preliminary Evaluation of the Excess of Initial Reactivity for Previous Levels of Operating Power). G. Focaccia and M. Perni (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Fisica Nuclear Applicata, Rome). Sept. 1962. 17p.

Results of a study concerning the initial excess reactivity as function of the power regime for the Triga reactor are presented. If a rise of reactor power is forseen, a modification of the core is necessary to obtain a larger reactivity value than that in the present design ($2). (J.R.D.)

13812 (NAA-SR-7087) SUMMARY REVIEW OF THE KINETICS EXPERIMENTS ON WATER BOILERS. M. S. Dunenfeld and R. K. Stitt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1963. Contract AT(11-1)-Gen-8. 80p.

With the objective of providing information for aqueous homogeneous reactor safety and hazards evaluations, experimental data and analysis of the kinetic behavior of five core loadings studied in the Kinetic Experiments on Water Boilers (KEWB) are presented. The experimental data cover the reactor response to ramp reactivity insertions for ramp rates up to $0.16/sec with total reactivity inputs up to $6.25, and step reactivity insertions up to $5.50. The core loadings range from solution volumes of 11.5 to 26.0 ℓ and fuel concentrations from 57 to 203 g of U^{235}/ℓ. A range of periods was investigated extending below 0.6 μsec and to peak powers in excess of 4000 Mw. The only safety limitation found in these experiments was an inertial pressure resulting from the production of radiolytic gas. The pressure was characterized as a function of reactor parameters by a series of experiments up to 620 psi. An analytic model of aqueous homogeneous reactor kinetics is presented. This model consists of the space independent kinetics equations with six groups of delayed neutrons, temperature compensation of reactivity with a quadratic coefficient in temperature, reflector moderated neutrons treated as a seventh delay group, and radiolytic gas void compensation of reactivity according to the model of aqueous homogeneous reactor void growth. An analytical expression was developed to predict peak pressure as a function of reactor parameters. Bursts computed with these models and experimental data from four KEWB reactor core loadings are in agreement. (auth)

13813 (NASA-TN-D-1560) LOW-POWER TESTS OF THE PLUM BROOK REACTOR. Harold W. Giesler, Harry J. Reilly, and William A. Poley (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 3, 1962. 49p.

A description is given of the low-power nuclear tests of the NASA Plum Brook Reactor. The core is described, and the measured performance is given. The tests included initial criticality, measurement of cold clean excess and shutdown reactivity, control-rod worth calibrations, temperature coefficients, and neutron and gamma flux mapping of the core and the reflector. Figures are included to show the most significant results. (auth)

13814 (NP-12512) FINAL SAFEGUARDS REPORT FOR THE GEORGIA TECH RESEARCH REACTOR. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station and General Nuclear Engineering Corp., Dunedin, Fla.). Jan. 1963. 170p.

A report prepared in support of a license application to operate the reactor is presented. Data and information are included concerning the reactor facility, site characteristics, the experimental program and anticipated use of the reactor, administrative controls, operating program, hazards evaluation, and emergency and disaster plans. (J.R.D.)

13815 REPLACEMENT OF THE COARSE CONTROL ARMS IN HIFAR. R. W. S. Carlson. At. Energy Australia, 6: 27-31(Jan. 1963).

The cadmium coarse control arms of the HIFAR reactor are described briefly. The remote handling operations and tools used in the replacement of the arms which had lost its absorption capacity are described in some detail. (D.L.C.)

13816 McMASTER UNIVERSITY REACTOR. Nucl. Energy, 46-9(Feb. 1963).

A description is presented of the design, operations, and programs of the McMaster University pool reactor. The reactor is operated at 1 Mw, and provision is made for 5-Mw operation in the future. Criticality was achieved in April 1959. (D.L.C.)

13817 RESEARCH REACTORS. V. V. Goncharov. Tr. Inst. Fiz. Akad. Nauk Gruz. SSR, 8: 3-14(1962). (In Russian)

A review of research reactors is given. The Soviet reactor IRT is described and compared with the American reactor BRR. (auth)

13818 NEW NUCLEAR REACTOR. V. Ya. Veldre. Vestn. Akad. Nauk SSSR, 32: No. 11, 88-90(Nov. 1962). (In Russian)

Descriptions are given of a new water-cooled, water moderated research reactor IRT-2000 in Salaspilis, Latvia. A γ source (30 kg equiv Ra) is developed through the use of a liquid indium-gallium-tin loop. (R.V.J.)

13819 PROGRAMMING AND UTILIZATION OF RESEARCH REACTORS. VOLUME 1. Proceedings of a Symposium held in Vienna, October 16-21, 1961. London, Academic Press, 1962. 340p. $9.00.

Twenty-five papers are included; separate abstracts have been prepared for 24. One of the papers was previously abstracted in NSA. Three of the papers are in French. (T.F.H.)

13820 SURVEY OF MAJOR PROBLEMS IN ESTABLISHING A RESEARCH REACTOR FACILITY. R. G. Bradley (U. S. Atomic Energy Commission, Washington, D. C.).

p.3-11 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The difficulties encountered throughout the entire development of a reactor project are described, and ways of avoiding them or resolving those which cannot be avoided are discussed. Some of the problems described are the technical justification for the reactor project, assurance of an adequate technical staff, and major delays in construction. (M.P.G.)

13821 PROBLEMS POSED BY THE CHOICE OF A REACTOR AND THE ELABORATION OF THE PRIMARY RESEARCH PROGRAM. P. Delattre (Centre d'Études Nucléaires, Saclay, France). p.13-38 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In French)

The general aspects of administration and organization of centers having research and training reactors and programs are reviewed. The implementation of research programs and particular applications of research reactors are detailed, with particular attention to prospecting and mineral studies, power-reactor analyses, technological research, radioisotope investigations, and basic research. The characteristics of several research reactors are described. (T.F.H.)

13822 AN APPROACH TO ESTABLISHING A NUCLEAR RESEARCH CENTER. George T. Schnurer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.39-55 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

A survey of some of the problems confronting the planners of a Nuclear Research Center is presented. The practical features of selecting an appropriate site and some special aspects of planning and constructing the Nuclear Research Center are discussed. Particular emphasis is placed on the means whereby construction costs can be reduced and time delays minimized. As such, attention has been focused on the planning sequences and administrative techniques whereby these ends can be accomplished. In addition, there is a discussion of the need for very early consideration of plans for adequate utilization of the facility. In this connection, some guidelines for establishing programs of training and research are presented. (auth)

13823 TRAINING PROGRAMS FOR REACTOR OPERATIONS AND REACTOR HAZARDS EVALUATION AT OAK RIDGE NATIONAL LABORATORY. F. T. Binford (Oak Ridge National Lab., Tenn.). p.57-76 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The three levels of skilled personnel required to design and operate a reactor are the nuclear reactor engineer, the operating engineer, and the reactor technician. ORNL training programs for operating engineers and technicians are described. The Oak Ridge School of Reactor Technology (ORSORT) was established in 1950 to train nuclear reactor engineers. The courses offered in ORSORT and the ORSORT-University Cooperative Program are described. In 1959, the ORSORT curriculum was changed to provide training in Reactor Operations Supervision and Reactor Hazards Evaluation, and the courses offered in this program are also described. (M.P.G.)

13824 REACTOR TRAINING PROGRAMS AND RESEARCH APPOINTMENTS AT THE INTERNATIONAL INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING. William J. Sturm (Argonne National Lab., Ill.). p.77-92 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The International Institute of Nuclear Science and Engineering (IINSE) at Argonne National Laboratory was founded in 1955. Its efforts are almost completely devoted to the training of students from outside of the U.S.A. The areas of training and research at IINSE are outlined, and the training facilities and staff are described. Training is available at two levels: Participant, of formal classroom-laboratory academic nature; and Affiliate, or research collaborator. The training and research programs for participants and affiliates are summarized. (M.P.G.)

13825 A REACTOR FOR MULTI-PURPOSE UNIVERSITY RESEARCH AND TRAINING. I. G. Campbell and M. J. Harris (Victoria Univ., Manchester, Eng.). p.93-103 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The reactor station being constructed at Risley, Lancashire to be used for research and training by Manchester and Liverpool Universities is described. The reactor is a heterogeneous, enriched, graphite-water moderated, water-cooled thermal reactor. A mean yearly output of 10 kw and a maximum output of 100 kw for short periods are anticipated. Proposed research programs in reactor physics and engineering, radiochemistry, and radiation chemistry are outlined, as well as postgraduate courses in nuclear engineering and nuclear chemistry. Supporting facilities are described, and estimated costs are given. It is hoped that the reactor will be commissioned by February, 1963. (M.P.G.)

13826 THE SPECIFICATION, DESIGN AND UTILIZATION OF A LOW-POWER REACTOR FOR RESEARCH AND TRAINING IN NUCLEAR ENGINEERING. J. M. Kay, P. J. Grant, C. G. James, and R. Vaux (Imperial Coll. of Science and Tech., London). p.105-14 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The design of the "Consort" reactor for Imperial College is described. The reactor is light-water moderated, uses enriched-U MTR-type fuel plates, and will have a thermal power of 10 kw. Details of the design, the arrangement of the building, and the provisional research program are presented. (M.P.G.)

13827 ENVIRONMENTAL SURVEYS AROUND THE MERLIN RESEARCH REACTOR. K. Boddy, D. R. Chick, and S. E. Hunt (Associated Electrical Industries, Aldermaston Court, Berks, Eng.). p.115-25 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The detection of direct radiation from the MERLIN reactor and the disposal and detection of radioactive gaseous and liquid effluent are described for normal reactor operation. Emergency procedures and equipment used in surveys to determine the inhalation hazard and contamination of exposed foodstuffs and milk are discussed. Practice exercises for a moderate release of activity have shown that the milk hazard delineation can be determined in ~2 hours, using the results of γ radiation surveys by mobile teams. (M.P.G.)

13828 RESEARCH REACTOR REQUIREMENTS IN THE LONDON AREA. W. Murgatroyd and W. K. Mansfield (Univ. of London). p.127-49 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The design of a research reactor, Jason (Mark VI), to meet the needs of the colleges, universities, and hospitals in the London area is described. The reactor experimental

facilities are reported in detail, and reactor siting and utilization are also discussed. (M.P.G.)

13829 THE PROJECT OF A RESEARCH REACTOR IN STYRIA AND FEASIBLE SCIENTIFIC PROGRAMMES. E. Ledinegg and P. Klaudy (Technische Hochschule, Graz, Austria). p.151-2 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

An Argonaut reactor will be installed in Styria to be at the disposal of 3 Styrian academic institutions and industry. In addition to routine applications it is planned to use the reactor for control problems and for investigations of neutron fluxes in reactors and cells of different lattice geometries and boundaries. (M.P.G.)

13830 INSTALLATIONS AND RELATED LABORATORIES. R. Uguen (Centre d'Études Nucléaires, Saclay, France). p.153-81 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In French)

Auxiliary equipment for research reactors is reviewed. Attention is devoted to equipment for guaranteeing and facilitating reactor functioning, such as storage areas, shops, annexes to reactor buildings, and engineering-drawing facilities; equipment for handling irradiated and unirradiated fuel; apparatus for manipulating experimental setups before, during, and after irradiation; and the principles and design of hot cells. (T.F.H.)

13831 PRIMARY PHASE IN THE DEVELOPMENT OF THE NUCLEAR CENTER OF MOL. J. Goens and M. d'Hont (Centre d'Etude de l'Energie Nucléaire, Brussels). p.187-96 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In French)

The activities of the laboratories at Mol comprise: applied research dealing with fuel cycles, reactors, and radioisotope production; basic research in physics, chemistry, and biology; personnel and environs radiation-monitoring duties; studies of reactor exploitation and applied mathematics; and machine and instrumentation shops. These activities, as well as the research, maintenance, administration, and protection of personnel are outlined. (T.F.H.)

13832 THE REACTOR FRM OF THE TECHNISCHE HOCHSCHULE MÜNCHEN ORGANIZATION. L. Koester (Technische Hochschule, Munich). p.197-202 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

A reactor group was formed to operate the FRM reactor and to supervise and provide technical assistance for reactor experiments. The group has three departments: reactor operation; health physics; and irradiations, measurements, and projects. The functions of each department are described. (M.P.G.)

13833 SELECTED TOPICS ON PLANNING, BUILDING AND OPERATING THE REACTOR CENTRE SEIBERSDORF. Michael J. Higatsberger (Österreichische Studiengesellschaft für Atomenergie, Reaktorzentrum Seibersdorf, Austria). p.203-13 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

Initial planning for the Seibersdorf reactor center is described, including the organizational setup of the Austrian Atomic Energy Society Ltd. and the reactor center, a program for reactor construction, and the selection of the ASTRA reactor. The construction and operation of the reactor center are also discussed. The center was officially opened in September, 1960. (M.P.G.)

13834 ORGANIZATION OF THE RESEARCH ESTABLISHMENT RISÖ OF THE DANISH ATOMIC ENERGY COMMISSION. Flemming Juul (Forsøgsanlaeg Risø, Roskilde, Denmark). p.215-30 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The experimental facilities of the Risø Research Center include: the DR 1, a thermal homogeneous solution-type research reactor operated at 2.3 kw; the DR 2, a light-water-moderated and -cooled heterogeneous research reactor with a thermal power of 5 Mw; the DR 3, a heavy-water-moderated and -cooled heterogeneous research reactor with a thermal power of 10 Mw; a 10-Mev electron linear accelerator; and a hot cell facility. The equipment, organization, buildings, uses, and operating costs are described for each facility. The staff and research activities of the departments and sections of the research center and the expenditures of the center are reported. (M.P.G.)

13835 EXPERIENCE GAINED IN THE CONSTRUCTION AND ELABORATION OF THE RESEARCH PROGRAMME OF THE RA REACTOR AT THE BORIS KICRIČ INSTITUTE, BELGRADE. P. M. Anastasijević, N. M. Raišić, and M. D. Ristić (Boris Kidrič Inst. of Nuclear Sciences, Belgrade). p.231-7 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The RA reactor is a Soviet TVRS-type heavy-water, 2% enriched reactor with a rated power of 6.5 Mw. Problems encountered in the utilization of the reactor are described, and fundamental and technological research programs for the reactor are outlined. The possibilities of international cooperation in the utilization of the reactor are mentioned. (M.P.G.)

13836 THE ORGANIZATION OF RESEARCH REACTORS AT THE CHALK RIVER LABORATORIES. D. D. Stewart and R. E. Manson (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.247-66 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The reactor facilities at Chalk River include: ZEEP, a natural U, heavy-water-moderated reactor with a graphite reflector and no provision for cooling; the NRX reactor, a heavy-water-moderated, light-water-cooled reactor with a power of 40 Mw; the NRU reactor, heavy-water-cooled and -moderated with a power of 200 Mw; the Pool Test Reactor, a 100 w swimming-pool type; and ZED-2, a zero-energy heavy-water-moderated reactor similar to ZEEP. The reactors and their research facilities are described. The organization of the Chalk River Project, the health and safety organization, and the distribution of personnel are reported. Experiments being performed (in 1961) in the NRX and NRU reactors are described, and typical costs of the research program are summarized. (M.P.G.)

13837 PROGRAMMING OF NUCLEAR RESEARCH REACTORS IN POLAND. Paweł J. Nowacki, Stanisław Andrzejewski, Jerzy Aleksandrowicz, and Wacław Frankowski (Inst. of Nuclear Research, Warsaw). p.267-72 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The research reactor at Swierk is a light-water-moderated and -cooled WWRS pool-type reactor with 10% enrichment and a nominal power of 2 Mw. The research facilities, utilization of the facilities, and operation of the reactor are described. A second research reactor, ANNA, should be completed in 1962, and its research and test facilities are outlined. The planning and coordination of nuclear research in Poland is described, and plans for three more research centers to be completed by 1970 are reported. (M.P.G.)

13838 ORGANIZATION OF THE RESEARCH PROGRAMME AND WORK IN AN INDUSTRY-OWNED NUCLEAR RESEARCH CENTRE. A. Rossi and E. Zimmer (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). p.273-7 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

In 1956, SORIN was founded by the Fiat and Montecatini companies for the purpose of applied nuclear research. A research center has been built at Saluggia. The center is entirely financed by private industry, and the research program is devoted primarily to the interests and needs of the parent companies. However, a fundamental research program has been developed on a limited basis. The organization of the research groups, some of the research projects, and the methods by which SORIN can perform experiments for outside companies and institutions are described. (M.P.G.)

13839 THE ROLE OF THE NUCLEAR REACTOR IN THE UNIVERSITY OF FLORIDA INTERDISCIPLINARY NUCLEAR CENTER. Robert E. Uhrig (Univ. of Florida, Gainesville). p.279-81 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The Argonaut-type nuclear reactor and associated facilities at the University of Florida are described. The reactor is used by staff members of many departments and is described as the common denominator of the research activities of an interdisciplinary nuclear research center. The organization of the research center is briefly outlined, and examples of interdepartmental cooperation in research are cited. (M.P.G.)

13840 THE ROLE OF REACTORS AND SUBCRITICAL ASSEMBLIES IN THE TECHNICAL PROGRAMS OF AMERICAN UNIVERSITIES. W. W. Grigorieff and F. A. Rohrman (Oak Ridge Inst. of Nuclear Studies, Tenn.). p.283-9 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

A brief history of the installation of reactors and subcritical assemblies in U. S. colleges and universities and a review of the financial assistance available for these installations are presented. The types of reactors installed and the advantages and disadvantages of critical and subcritical assemblies are summarized. The utilization of reactors by educational institutions is discussed, including proposed and actual research and engineering programs. (M.P.G.)

13841 INTEGRATION OF RESEARCH REACTOR CENTERS WITH OTHER RESEARCH EFFORTS. Glenn Murphy and Virginia P. Denisen (Iowa State Univ., Ames). p.291-9 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The three phases of research (basic research, data or developmental research, and applied research) and three types of research organizations (university, government laboratory, and industry) are described. The types of research best carried on by these organizations and the interrelationships among these organizations are discussed. The function of national laboratories or reactor research centers is described. The types of research programs that may be undertaken by research centers with small reactors are outlined, and the research programs and laboratory experiments performed on the Iowa State University Argonaut-type reactor are listed. (M.P.G.)

13842 PLANNING A RESEARCH REACTOR START-UP PROGRAMME. Robert Skjoeldebrand (AB Atomenergi, Studsvik, Tystberga, Sweden). p.301-9 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The purposes of reactor start-up tests are the verification of physics calculations, including reactor kinetics, the checking of safeguards, and the securing of information for researchers. A research reactor commissioning program and the information it should obtain is described for heterogeneous light-water-moderated, enriched cores typical of pool reactors in the power region of 300 kw to 5 Mw. For illustration, data are presented from criticality experiments, shim-rod calibrations, and flux measurements on the R2 reactor. (M.P.G.)

13843 TECHNICAL AND ORGANIZATIONAL PROBLEMS PRESENTED BY PUTTING THE 2 MW SWIMMING POOL REACTOR AVOGADRO RS1 INTO OPERATION. Edmondo Pedretti and Gualtiero Horn (SORIN, Centro Ricerche Nucleari, Saluggia, Italy). p.311-22 of "Programming and Utilization of Research Reactors. Vol. 1." London, Academic Press, 1962. (In English)

The technical and organizational problems presented by putting the reactor into operation are described: preparing the reactor start-up, calibrating the reactor at low and high power, beginning experimental use, increasing the operation power, and preparing full-time reactor operation. The solutions adopted in each stage of the work are described, with particular regard to the electronic and nuclear instrumentation, special equipment for a swimming-pool reactor, scheduling of the experiments and operational training of personnel. (auth)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstract 12585.

13844 (N62-10945) RESEARCH ON SPUTTERING PHENOMENA, SURFACE STABILITY AND VOLTAGE BREAKDOWN FOR ALKALI-COATED REFRACTORY ELECTRODES. Quarterly Report No. 1, May 1, 1961–July 31, 1961. R. L. Strayer and F. M. Charbonnier (Linfield Coll., McMinnville, Ore. Research Inst.). Contract NASr-19. 11p.

Activities in an investigation aimed at achieving understanding and control of processes which lead to voltage breakdowns in ion propulsion systems are reported. The research is centered around surface stability, sputtering phenomena, and voltage breakdown for alkali-coated refractory electrodes. A review of previous work on surface stability is included along with a discussion of preliminary work on field emission. Work is also reported on design of a tube to study the migration and desorption of Cs on W. Plans for a study of voltage breakdown between Cs-coated W electrodes are also reported. (J.R.D.)

13845 (N62-11120) DESIGN, FABRICATION, AND TESTING OF A CESIUM ION ROCKET ENGINE. Quarterly Progress Report No. 1, September 1, 1960 through November 30, 1960. (Hughes Aircraft Co. Hughes Research Labs. Malibu, Calif.). Contract NAS5-517. 72p.

Activities in a program to develop a laboratory ion engine capable of producing a 0.01 lb thrust at a specific impulse of about 6000 sec are reported. Design work devoted to ion engines is discussed along with design and fabrication of a propellant feed system, an engine test chamber, and a thrust platform. Completion of a hollow-beam electrolytic tank is reported. Analytical work to gain a better understanding of the space-charge-neutralization processes was carried out and ionizer research was started. (J.R.D.)

13846 (NP-12541) RESEARCH AND DEVELOPMENT ON ELECTRODEPOSITED COATINGS FOR HIGH TEMPERATURE EXPERIMENTAL SOLID PROPELLANT ROCKET NOZZLES. Sixth Quarterly Report, September 30–December 29, 1962. (Value Engineering Co., Inc., Alexandria, Va.). Jan. 29, 1963. Contract DA-36-034-ORD-3497. 17p.

Activities in a program to further develop and adapt an electrodeposited Cr-base cermet for protection of solid propellant rocket nozzles. A group of Cu samples were coated with compositions such as Cr, Cr–ZrB_2, Cr–ZrB_2 on graphite, and Cr–ZrB_2 on a proprietary dispersant to determine the particle volume and distribution in the cermet. Results of x-ray analyses of these samples indicate that specimens coated in baths containing the dispersing agent contained more ceramic particles than those coated in conventional baths. It appears that more ceramic particles can be introduced in the coating by mechanical stirring of the bath, and use of increased amounts of dispersant and ceramic materials. The relations of ceramic particle concentration and the coating resistance to high-temperature corrosion was not established. Design of an O_2–H_2 rocket motor to operate at 600 psi is reported. The motor was calibrated to establish the throttle settings to obtain various chamber pressures and flame temperatures. Tests were also conducted to increase nozzle life. (J.R.D.)

13847 THE ENGINE INTERNAL ENVIRONMENT. TEMPERATURE REQUIREMENTS FOR NUCLEAR PROPULSION. R. W. Bussard (Space Technology Labs., Inc. [Canoga Park, Calif.)]. Aerospace Eng., 22: No. 1, 32-8 (Jan. 1963).

The general requirements of high-temperature nuclear propulsion systems are discussed, and possibilities for filling these requirements are assessed. Fission reactors and nuclear/electric propulsion systems are considered, and problems common to chemical and nuclear rocket engines are discussed. (D.L.C.)

13848 THERMAL PROTECTION OF ROCKET-MOTOR STRUCTURES. Eugene P. Bartlett (Aeronautronic Div. of Ford Motor Co., Los Angeles). Aerospace Eng., 22: No. 1, 86-99(Jan. 1963).

The relative merits of several methods of thermal protection are compared for liquid-rocket motors operating at high temperatures, long durations, and with restart. It is concluded that the most promising light-weight designs employ high-density polycrystalline and pyrolytic graphites as the liner materials. However, designs employing tungsten and tantalum carbide, although heavier, are also of interest as they could offer increased erosion resistance in some propellant systems. (auth)

13849 THERMAL PROTECTION OF LIFTING RE-ENTRY VEHICLES. Wilfred H. Dukes and Frank M. Anthony (Bell Aerosystems Co., Buffalo). Aerospace Eng., 22: No. 1, 108-24(Jan. 1963).

An analysis is made of the maximum re-entry performance required of a lifting re-entry vehicle, assuming a maximum re-entry velocity of 36,000 fps. It is concluded that it should be possible to protect the lower surface of an aluminum airframe with a weight of 4.5 lb/ft^2. The possible thermal protection systems and the required materials development are discussed. (D.L.C.)

13850 NUCLEAR ROCKETS. Robert Fox (Univ. of California, Livermore). Space/Aeron., 37: 67-9(Apr. 1962).

The prospects for nuclear propulsion of manned and unmanned spacecraft are analyzed. The effects of biological shielding and radiator requirements on the nuclear-system efficiency are described. (T.F.H.)

13851 PROCEEDINGS OF THE NASA-UNIVERSITY CONFERENCE ON THE SCIENCE AND TECHNOLOGY OF SPACE EXPLORATION, CHICAGO, ILLINOIS, NOVEMBER 1-3, 1962. VOLUME 2. (National Aeronautics and Space Administration, Washington, D. C.). Dec. 1962. 538p. (NASA SP-11(Vol. 2)). $3.00 (GPO).

Volume 2 contains 41 papers from 10 sessions on chemical rocket propulsion, nuclear propulsion, power for spacecraft, electric propulsion, aerodynamics, gas dynamics, plasma physics and magnetohydrodynamics, laboratory techniques, materials, and structures. Three introductions to sessions and the concluding remarks to one session are also included. Separate abstracts have been prepared for 19 papers. (M.P.G.)

13852 ADVANCED CONCEPTS FOR NUCLEAR ROCKET PROPULSION. Frank E. Rom and Robert G. Ragsdale (National Aeronautics and Space Administration, Cleveland). p.63-75 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The advantages and disadvantages of homogeneous thermal reactors, fast reactors, and heterogeneous thermal

reactors for rocket propulsion are discussed. The heterogeneous thermal reactor seems to have the greatest potential for producing a high specific impulse. A table of properties of refractory materials for fuel elements is presented. Tungsten combined with UO_2 appears to have the greatest potential for producing the highest specific impulse attainable by solid-core nuclear rockets. Reactor-weight comparisons, design problems, and experimental investigations on solid-core reactors are described. The basic concept of gaseous-core reactors is discussed. The potential performance of gaseous-nuclear rockets is far beyond that of advanced solid-core systems. (M.P.G.)

13853 NUCLEAR PHYSICS OF SOLID-CORE GAS-COOLED ROCKET PROPULSION REACTORS. Donald Bogart and Edward Lantz (National Aeronautics and Space Administration, Cleveland). p.77-85 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The design of a nuclear-rocket reactor that will produce maximum propellant-gas temperature for limited core-material temperature requires successful integration of the mechanical, thermal, and nuclear aspects of a complex problem. The strong interaction of the three-dimensional heat generation with heat transfer to the propellant requires "tailoring" of reactor composition and geometry. The techniques used are zoning of uranium concentration, metering of gas flow through fuel-element cooling passages, core-moderator zoning, and judicious use of reflectors. Control systems should encompass sufficient excess reactivity to start, shutdown, and restart a nuclear-rocket engine without introducing severe power distortions. Heterogeneous moderated reactors that use tungsten, which exhibits neutron resonance absorption, require that fuel-element-moderator lattices be optimized to produce maximum neutron multiplication. (auth)

13854 FLUID-FLOW AND HEAT-TRANSFER PROBLEMS IN NUCLEAR ROCKETS. Herman H. Ellerbrock, John N. B. Livingood, and David M. Straight (National Aeronautics and Space Administration, Cleveland). p.87-116 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

Core, reflector, and nozzle heat-transfer and flow problems that require solutions before adequate nuclear rockets can be designed are presented. Core problems, such as maintaining allowable temperatures and calculating thermal stresses, are included. Core flow-stability problems are also discussed. Reflector two-phase- and gaseous-hydrogen heat-transfer and pressure-drop correlations are illustrated with experimental data. Examples of oscillations and maldistributions in the reflector and discussion of gravitational effects on flow and heat transfer are included. Limitations of nozzle-design methods are reviewed. A careful investigation of the aforementioned problems revealed that adequate knowledge is not yet available for the determination of satisfactory solutions. More intensive research in such areas as oscillatory flow, maldistribution of flow, two-phase flow, nozzle heat transfer, and stress-calculation methods is urgently needed before improved nuclear rockets can be designed. (auth)

13855 PROBLEMS IN DYNAMICS AND CONTROL OF NUCLEAR ROCKETS. John C. Sanders, Herbert J. Heppler, Jr., and Clint E. Hart (National Aeronautics and Space Administration, Cleveland). p.117-22 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

A nuclear-rocket flow system is described, and control problems and operational limits are discussed. Factors influencing the design of a control system include ability to control rate of neutron multiplication and gas temperature and the detection of a wide range of neutron flux. A block diagram of a possible control system is presented, and the dynamics of reactor performance and startup are analyzed. Careful selection of the control is required to prevent flow and flux instabilities during startup. Problems needing further research are listed. (M.P.G.)

13856 POWER FOR SPACECRAFT. Newell D. Sanders, Charles A. Barrett, Daniel T. Bernatowicz, Thomas P. Moffitt, Andrew E. Potter, Jr., and Harvey J. Schwartz (National Aeronautics and Space Administration, Cleveland). p.125-50 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The power requirements for present and future space missions are described. Solar photovoltaic cells are used in satellites that require power for more than a few months. Some of the problems of solar cells, including radiation damage and the complexity and weight of solar-cell power systems, are discussed. The use of batteries and radioisotope power supplies is also mentioned. Fuel cells are good power systems where moderate power is required for periods up to several weeks. Two H-O fuel-cell systems, the modified Bacon cell designed for the Apollo mission and the ion exchange membrane cells designed for the Gemini mission, are compared, and other types of fuel cells are briefly described. Other sources of power include chemically fueled engines, solar heat collectors, and nuclear reactors. Brayton cycle systems, thermionic converters, and low- and high-power Rankine cycle systems can be used to convert power from reactors or solar heat sources. The advantages and disadvantages of utilizing these power sources and conversion systems in spacecraft are discussed. The problems of obtaining suitable materials for the reactor, boiler, and radiator in Rankine cycle systems are described. (M.P.G.)

13857 SPECIAL REQUIREMENTS ON POWER GENERATION SYSTEMS FOR ELECTRIC PROPULSION. Seymour Lieblein (National Aeronautics and Space Administration, Cleveland). p.157-66 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

Nuclear turbogenerator power conversion systems appear to be the most attractive type of powerplant system for long-range missions. The basic elements of the turbogenerator system based on a Rankine vapor cycle are described. The problems involved in the design of radiators to dissipate waste heat are discussed. The protection of the radiator against meteoroid impact is a critical problem, introducing large uncertainties in the design of the radiator and the weights of the powerplants. Approaches to the solution of the meteoroid problem are suggested. (M.P.G.)

13858 GENERATION OF THRUST — ELECTROTHERMAL THRUSTORS. John R. Jack (National Aeronautics and Space Administration, Cleveland). p.167-70 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

A specific impulse of the order of 1000 seconds can be

achieved with fairly good efficiency by an electrothermal thrust generator. Two engine configurations, one using an arc-heated jet and the other using a resistance-heated hydrogen jet, are described, and the advantages and disadvantages of each are discussed. An analysis of the heat-transfer characteristics of hydrogen and helium propellants is presented. Suitable propellants are evaluated, and graphs of frozen-flow efficiency as a function of specific impulse for various propellants are presented. It appears feasible to design a thrustor with the desired performance characteristics and a good conversion efficiency, although several major problems require additional research. (M.P.G.)

13859 GENERATION OF THRUST — ELECTROMAGNETIC THRUSTORS. George R. Seikel (National Aeronautics and Space Administration, Cleveland). p.171-6 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The general principles of electromagnetic acceleration, the properties of plasma propellants, and methods of plasma acceleration are reviewed. Some devices which use an electromagnetic force to accelerate a plasma propellant are described. These include the traveling-magnetic-wave a-c accelerator, the coaxial-plasma-gun pulsed accelerator, and 2 d-c accelerators, the Hall-current ion accelerator and a nonequilibrium electrothermal magnetically contained accelerator. Electromagnetic accelerators should be able to provide relatively small thrustors capable of power levels above a megawatt, although further development is required, especially in the fields of plasma physics and plasma diagnostic techniques. (M.P.G.)

13860 GENERATION OF THRUST — ELECTROSTATIC THRUSTORS. Warren D. Rayle (National Aeronautics and Space Administration, Cleveland). p.177-82 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The fundamental processes of electrostatic propulsion, the generation and acceleration of charged particles and the neutralization of the resultant beam, are outlined. Three types of electrostatic thrustors are described. The contact engine using cesium as a propellant and the electron-bombardment engine using mercury are in the operational prototype stage. Future work is required to improve efficiency, durability, and thrust-to-weight ratio. A third type, the colloidal-particle engine, is in an embryonic state but promises to have high efficiency in the low-specific-impulse region. Some possible future developments that might change the present emphasis in electric propulsion research are pointed out. (M.P.G.)

13861 ADVANCED CONCEPTS. Edmund E. Callaghan (National Aeronautics and Space Administration, Cleveland). p.183-9 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

A new propulsion concept based on a radioisotope electrogenerator combined with a colloidal-particle electrostatic rocket engine is described. Design studies of a spacecraft using this means of propulsion show a specific powerplant weight of $\sim\frac{1}{2}$ lb/kw. The concept of a thermonuclear rocket is reviewed. A possible propulsion system using D–He^3 is outlined. Specific powerplant weights of less than 1 lb/kw appear possible with the described configuration. Both propulsion systems must overcome serious problems before they are feasible. Since many uses of intense magnetic fields are anticipated, NASA research on magnetics, cryogenics, and superconductivity is discussed. (M.P.G.)

13862 RELATIONS BETWEEN AERODYNAMICS AND MAGNETOHYDRODYNAMICS. Adolf Busemann (National Aeronautics and Space Administration, Langley Field, Va.). p.304-12 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

Although aerodynamics is approaching a state of perfection, at least in connection with turbulence, some important parts have not been completed. For example, magnetohydrodynamics, or the combination of aerodynamics and electromagnetic forces in electrically conductive fluids or ionized gases (called plasma), is a rather young science. Interesting results for technical or for astronomical application are known, but many controversies are still going on. One of the more obvious reasons that some of the results touch on a new version of very old problems is seen in the fact that under equal conditions, hydrodynamic forces and magnetic forces have opposite sign and thus reverse the situation when the magnetic field strength becomes predominant. (auth)

13863 FUNDAMENTALS OF PLASMA INTERACTION WITH ELECTRIC AND MAGNETIC FIELDS. Robert V. Hess (National Aeronautics and Space Administration, Langley Field, Va.). p.313-36 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The fundamental aspects of the interaction of plasmas with electric and magnetic fields are treated through specific examples from actual problems of research. For instance, the dielectric behavior of a plasma in a strong magnetic field which applies to capacitive energy storage and Alfvén waves is discussed. The equations of motion of electrons and ions in a plasma including collisions and space charge effects are unified. The plasma is treated as a single fluid with velocity, current, and various transport properties, such as electrical conduction. The single-fluid approach is applied to a variety of methods of steady plasma acceleration and to the acceleration of ions in a plasma. Collision processes and electrical conduction are given for fully and partially ionized plasmas with and without a magnetic field. Their effect on voltage current characteristics of electrical discharges in the presence of magnetic fields is discussed for a variety of experiments. Examples of turbulent electrical conduction are given. (auth)

13864 THE ELECTRIC DRAG FORCES ON A SATELLITE IN THE EARTH'S UPPER ATMOSPHERE. George P. Wood (National Aeronautics and Space Administration, Langley Field, Va.). p.337-45 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

A theoretical study has been made of the electric drag forces acting, as a result of the electric charge on the sphere, on a spherical satellite in free-molecule flow in the upper atmosphere. The analysis has been applied to a 4-meter-diameter earth satellite at an altitude of 1,500 kilometers. The calculations have yielded charge-density distribution and potential distribution in the sheath, the ion trajectories, the increased ion-impact drag, the ion-scattering drag, and the induction drag due to the earth's

magnetic field. These three electric drags total about 3½ percent of the drag of the uncharged sphere for average conditions between maximum and minimum of sunspot activity. The percentage would be approximately doubled at the maximum and approximately halved at the minimum. (auth)

13865 PLASMA FREQUENCY AND RADIO ATTENUATION. Paul W. Huber and Clifford H. Nelson (National Aeronautics and Space Administration, Langley Field, Va.). p.347-60 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The problem of radio-frequency attenuation due to the interaction of an electromagnetic wave and a plasma layer is reviewed with particular attention to that aspect dealing with communications during the reentry phase of space-flight missions. The need for concerted effort on the problem is first brought out by the projection of radio blackout data from current missions to that of second-generation missions. The electromagnetic plasma parameters are discussed in relation to their influence on the wave propagation properties. It is shown that theoretical models of wave-plasma interaction (absorption and reflection) can be synthesized to approximate the reentry plasma-layer problem, which is interaction with relatively dense plasmas having gradients of finite extent with respect to a signal wavelength. Comparison of flight results with those obtained with a simplified conceptual model is presented. Finally, various means by which the attenuation problem may be alleviated or circumvented are reviewed and the capabilities for laboratory and flight model tests are outlined. (auth)

13866 SURVEY OF PLASMA ACCELERATOR RESEARCH. Macon C. Ellis, Jr. (National Aeronautics and Space Administration, Langley Field, Va.). p.361-81 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

A brief summary is given of the role of plasma acceleration in modern technology, including space exploration. The various types of plasma accelerators which are described and for which the current research status and problems are discussed include continuous-flow, direct-current, crossed-field accelerators; continuous-flow accelerators utilizing Hall currents; accelerators utilizing traveling-wave concepts; and pulsed, coaxial plasma guns. (auth)

13867 HIGH-VACUUM TECHNIQUES FOR RESEARCH. Jack L. Taylor (California Inst. of Tech., Pasadena). p.391-409 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

The production and maintenance of high and ultra-high vacuums are described. Types of vacuum pumps, including diffusion, sputter-ion, cryogenic, and turbo-molecular drag pumps, are described, and the range of vacuum pressure that can be achieved with them is given. The use of traps, seals, and baking to obtain ultra-high vacuums, the conductance of the vacuum system, and the types of gages used to measure vacuums are discussed. Examples are presented to illustrate the use of high vacuums in research. The examples include a high-temperature tensile furnace, a cryogenic gyro, a biological experiment on the survival of microorganisms in space, friction-and-wear testing equipment, an ion-propulsion engine, a fission electric cell, and a space simulator. (M.P.G.)

13868 GENERATION OF MAGNETIC FIELDS BY FLUX COMPRESSION IN SUPERCONDUCTORS. Daniel D. Elleman (California Inst. of Tech., Pasadena). p.429-35 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

A method for producing intense magnetic fields is described. A superconductor in an external magnetic field is cooled below its critical temperature, thereby trapping the flux enclosed by the superconductor. The flux remains constant, even when the external magnetic field is removed, if the cross-sectional area normal to the field does not change. If the area is reduced by means of a piston, the flux is compressed, and the magnetic field within the area enclosed by the superconductor is increased. Formulas are presented to calculate the value of the magnetic field obtained by flux compression. Cyclic flux pumps using this principle are described. Fields of the order of 10 kG were obtained in chambers or coils 1 or 2 cm in diameter. Flux pumps can also be used as "magnetic vacuum pumps" to pump magnetic flux out of a chamber. Using a Nb_3Zr flux pump, a field of 0.2 milligauss was obtained. This field showed changes of less than 10^{-3} milligauss when the external field was varied several gauss. A superconducting flux compressor was used to measure the penetration of flux into Nb_3Sn. A graph of penetration depth as a function of magnetic field is presented. (M.P.G.)

13869 SPACE ENVIRONMENT AND ITS EFFECTS ON MATERIALS. Don D. Davis, Jr. (National Aeronautics and Space Administration, Langley Field, Va.). p.439-49 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

Three aspects of the space environment that influence the selection of materials for use in space-craft are considered: namely, vacuum, particle radiation, and meteoroids. To the best of our knowledge, vacuum effects have not so far been a serious problem for spacecraft. On the other hand, several spacecraft failures have been attributed to radiation, and confirmation of the suspected effects has been obtained in the laboratory. The extent of the hazard from meteoroids is uncertain. The most urgent need here is for reliable and accurate direct measurements of damage. (auth)

13870 NONMETALLIC MATERIALS FOR SPACECRAFT. George F. Pezdirtz (National Aeronautics and Space Administration, Langley Field, Va.). p.451-60 of "Proceedings of the NASA-University Conference on the Science and Technology of Space Exploration. Vol. 2." Washington, D. C., National Aeronautics and Space Administration, 1962.

Nonmetallic materials have many unusual and desirable properties for use in spacecraft applications, but their sensitivities to the ultraviolet and high-energy ionizing radiation of space have created problems — some as yet unsolved. The problems of thermal control coatings, polymers, and composites in space applications are discussed. The need for new nonmetallic materials with unusual properties such as inorganic polymers is also examined. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 12366 and 13739.

13871 (JEN-108-DMa/1-15) TREATMENT AND HANDLING OF RADIOACTIVE WASTES IN THE ANDÚJAR URANIUM MILL. C. Perez Perea, E. Iranzo Gonzalez, and D. Lara Saenz (Spain. Junta de Energiá Nuclear, Madrid). 1962. 37p.

A description of the Andújar Uranium Mill, the radioactive wastes produced in the manufacturing process, their treatment before disposal to the Guadalquivir River, and the survey made to determine the concentration of radioactive contaminants are given. Waste treatment consists of neutralization with lime to pH-8, disposal of solids in a tailing pond, and decantation of liquid effluent in a pool before final disposal. The decontaminations average 87%, 90%, 94%, and 96% with respect to U, Ra, and gross alpha and beta activities sufficient to produce no practical change in the radioactivity of the river water. Methods of analysis used and an overall Ra balance of the process are included. (auth)

13872 FISSION PRODUCT STORAGE IN GLASS. Atomics, 16: 19-20(Jan.-Feb. 1963).

Progress in the development of a commercially practicable process for storing glass is discussed. In the process described, the concentrated acid fission product solution is fed, together with silica and boric acid, into a heated reactor vessel where the nitrates are decomposed and the glass formed. It is possible to make glass blocks in 6-in. × 5-ft containers by this method. (M.C.G.)

13873 RADIOACTIVE WASTES. Walter G. Belter. Intern. Sci. Tech., No. 12, 42-3; 46-51(Dec. 1962).

Problems associated with the disposal of radioactive wastes from nuclear power plants are discussed. A procedure for waste disposal is outlined that includes the reduction of waste volume, discharge of low-activity waste to the environment, conversion of acidified high-activity liquid waste into neutralized unleachable solids, packaging of solids for perpetuity, and the disposal of high-activity solid wastes to deeply buried dry and impervious environments such as salt mines. (C.H.)

13874 RADIOACTIVE WASTE MATERIAL. H. J. Wervers. R.C.N. (Reactor Centrum Neder.) Mededel., No. 7, 9-23(1962). (In Dutch)

A series of six articles is presented. Topics discussed include the origin of radioactive wastes; radioactive contamination of earth, water, and air; biological accumulation of radioisotopes; methods for the treatment of radioactive waste materials; radioactive monitoring of water; problems of ultimate disposal; and problems of radioactive wastes. (J.S.R.)

13875 IMPROVEMENTS IN THE PRECIPITATION OF CHARGED PARTICLES FROM GASES. Frank Harlen (to Dowty Electrics Ltd.). British Patent 916,322. Jan. 23, 1963. Filed Feb. 19, 1958.

A chamber was described that has one or more gas inlet passages so directed to cause gas, on entry, to flow over the walls of the chamber. An electric field filled the interior of the chamber to urge decay products that carry an electric charge to an axially disposed conductor. The volume of the chamber and the rate of flow of gas were such that the time for gas to pass through the chamber was comparable to the time of decay of fission products. (C.E.S.)

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This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

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ALLIS-CHALMERS MFG. CO. ATOMIC ENERGY DIV., WASHINGTON, D. C.
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ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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285	17-12391	See BNL-764
CDRP-	**(Non-AEC)**	
182-114	17-12451	
CEA-	**(French)**	
2141	17-12362	Dep.(mc)
2188	17-13338	Dep.(mc)
2189	17-12754	
2191	17-12491	Dep.(mc)
2206	17-12554	Dep.(mc)
2216	17-13483	Dep.(mc)
CEX-		
61.4	17-12492	Dep.: $2.25(OTS)
CNEN-	**(Italian)**	
131	17-13807	Dep.(mc)
136	17-13808	Dep.(mc)
137	17-13809	Dep.(mc)
138	17-13810	Dep.(mc)
139	17-13811	Dep.(mc)
CREL-	**(Canadian)**	
883	17-13613	Dep.(mc)
CRER-	**(Canadian)**	
1120	17-12493	Dep.; $0.50(AECL)
CRRP-	**(Canadian)**	
1124	17-12662	Dep.; $1.50(AECL)
1127	17-13665	Dep.; $1.00(AECL)
DASA-	**(Misc.)**	
1259*	17-12392	$21.00(OTS)
1312*	17-12075	Dep.; $4.60(OTS)
1313*	17-12076	$1.60(OTS)
1316*	17-12077	
1334*	17-12078	$2.60(OTS)
1335*	17-12079	
DC-	**(Misc.)**	
61-7-10	17-12663	Dep.(mc); $1.60(fs), $0.80(mf) OTS
DL-	**(Non-AEC)**	
50	17-13776	Dep.; $0.50(AECL)
DLCS-		
5001262	17-13777	Dep.(mc); $5.60(fs), $1.82(mf) OTS
DP-		
804	17-12580	Dep.; $0.75(OTS)
815	17-13672	Dep.; $0.75(OTS)
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EFINS-	**(Misc.)**	
62-62	17-13669	Phys. Rev. 129: 2361-2(1963)
62-79	17-13484	Dep.(mc); $5.60(fs), $1.85(mf) OTS
EOS-	**(Non-AEC)**	
3410-Q-1	17-12589	See NP-12543
ER-	**(Misc.)**	
4322*	17-12759	See N62-11129
4540*	17-12757	See N62-10970
4670	17-13679	See NAA-SR-6305
6047*	17-12720	See NP-12501
ETR-	**(Belgian)**	
110	17-12364	See NP-12394
EURAEC-		
125	17-12594	Dep.(mc); $2.60(fs), $0.92(mf) OTS
309	17-12595	Dep.(mc); $5.60(fs), $1.73(mf) OTS
378	17-12634	Dep.(mc); $14.50(fs), $6.77(mf) OTS
461	17-12635	Dep.(mc); $3.60(fs), $1.40(mf) OTS
501	17-12636	Dep.(mc); $1.60(fs), $0.80(mf) OTS
FRL-TN-	**(Non-AEC)**	
90	17-12134	$1.60(OTS)
FTD-TT-	**(Non-AEC)**	
62-1495	17-12534	OTS
62-1529	17-12535	OTS
62-1689	17-12135	OTS
62-1814	17-13688	OTS
GA-	**(Misc.)**	
3620	17-12739	To be published in TID-7654
GA-tr-		
2704	17-12428	Dep.(mc); $2.60(fs), $1.01(mf) JCL
GAMD-	**(Misc.)**	
2221(Rev.)	17-12628	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3779	17-13673	Dep.(mc); $2.60(fs), $0.83(mf) OTS

Report No.	Abstract No.	Availability
GEAP–	**(Misc.)**	
3885	17-13674	Dep.(mc); $9.10(fs), $3.47(mf) OTS
3983	17-12715	Dep.; $0.50(OTS)
4001	17-13675	Dep.(mc); $6.60(fs), $2.12(mf) OTS
4049	17-13676	Dep.(mc); $4.60(fs), $1.67(mf) OTS
4060	17-12664	Dep.; $1.00(OTS)
4095	17-12665	Dep.; $0.75(OTS)
4137	17-12716	Dep.(mc); $2.60(fs), $1.07(mf) OTS
HPR–	**(Norwegian)**	
10	17-13677	Dep.(mc)
HW–		
62422	17-12717	Dep.(mc); $1.10(fs), $0.80(mf) OTS
64154	17-12393	Dep.(mc); $1.60(fs), $0.80(mf) OTS
67949(Rev.)	17-12718	Dep.; $0.50(OTS)
75914	17-13678	Dep.; $2.50(OTS)
HW-SA–		
2632	17-12225	Dep.(mc); $1.60(fs), $0.80(mf) OTS
HWS–		
7441	17-12633	See TID-17862
7444	17-12611	See TID-17861
IDO–		
11001	17-12309	Dep.; $0.50(OTS)
16820(Vols.I&II)	17-13778	Dep.; $7.00(OTS)
IS–		
106	17-12283	Revs. Modern Phys., 34: 326-76(1962)
313	17-13614	Dep.; $2.50(OTS)
478	17-12282	Record Chem. Progr. (Kresge-Hooker Sci. Lib.) 23: 195-221(1962)
485	17-13175	Revs. Modern Phys., 34: 190-214(1962)
580	17-12246	J. Am. Chem. Soc. 85: 112-13(1963)
JEN–	**(Spanish)**	
108-DMa/1-15	17-13871	Dep.(mc)
111-DF/132	17-13339	Dep.(mc)
JINR–	**(Russian)**	
E-1114	17-13340	Dep.(mc)
E-1122	17-13341	Dep.(mc)
E-1131	17-13342	Dep.(mc)
E-1145	17-13485	Dep.(mc)
P-1109	17-13343	Dep.(mc)
P-1119	17-13486	Dep.(mc)
P-1121	17-12755	Dep.(mc)
P-1124	17-13344	Dep.(mc)
P-1126	17-12756	Dep.(mc)
P-1130	17-13487	Dep.(mc)
P-1132	17-13345	Dep.(mc)
P-1137	17-13346	Dep.(mc)
P-1138	17-13347	Dep.(mc)
P-1141	17-13348	Dep.(mc)
P-1144	17-12555	Dep.(mc)
P-1149	17-13349	Dep.(mc)
P-1152	17-13350	Dep.(mc)
JPRS–	**(Non-AEC)**	
16900	17-12101	OTS
17161	17-12136	$1.10(OTS)
17403	17-12233	$0.50(OTS)
KAPL-M–		
RFS-3	17-12528	Dep.(mc); $2.60(fs), $0.98(mf) OTS
KFK–	**(German)**	
118	17-13805	Physik. Verhandl., Verband Deut. Physik. Ges. 2: 405-15(1962)

Report No.	Abstract No.	Availability
KR–	**(Norwegian)**	
32	17-12529	Dep.(mc)
LA–		
2765	17-12452	Dep.; $2.25(OTS)
LADC–		
4882	17-12235	Acta Cryst. 16: 105-9(1963)
5419	17-12267	J. Phys. Chem. 67: 318-23(1963)
5469	17-13655	Rev. Sci. Instr. 34: 56-60(1963)
5496	17-12563	J. Geophys. Res. 68: 663-5(1963)
5502	17-13308	J. Geophys. Res. 68: 657-61(1963)
LAMS–		
2747	17-12581	Superseded by LAMS-2801
2801	17-12581	Dep.; $1.25(OTS)
2832	17-12181	Dep.; $0.50(OTS)
MATT–		
121	17-13654	Rev. Sci. Instr. 34: 12-18(1963)
MITNE–	**(Misc.)**	
18	17-13470	See NYO-9657
ML–	**(Misc.)**	
890*	17-13618	$3.60(OTS)
MMPP-S–	**(Non-AEC)**	
1	17-12494	Dep.(mc)
N–	**(Misc.)**	
62-10428*	17-13353	See RM-2936-ARPA
62-10945*	17-13844	$1.60(fs), $0.80(mf) OTS
62-10970*	17-12757	$1.60(fs), $0.80(mf) OTS
62-11080*	17-13618	See ML-890
62-11118*	17-12758	$1.60(fs), $0.80(mf) OTS
62-11120*	17-13845	$7.60(fs), $2.54(mf) OTS
62-11129*	17-12759	$1.60(fs), $0.80(mf) OTS
62-11289*	17-13296	$1.10(fs), $0.80(mf) OTS
62-11554*	17-12080	$3.60(fs), $1.22(mf) OTS
62-11789*	17-13629	See TIL/T-5273
62-12088*	17-12626	See AD-275787
62-12533*	17-12223	See AD-275763
62-12598*	17-12719	$4.60(fs), $1.46(mf) OTS
NA–	**(Non-AEC)**	
57H-527-17	17-12666	$14.00(OTS)
NAA-SR–		
5599	17-13779	Dep.; $1.00(OTS)
6305	17-13679	Dep.(mc); $11.50(fs), $4.79(mf) OTS
7087	17-13812	Dep.; $2.00(OTS)
7654	17-12667	Dep.; $0.50(OTS)
7705	17-13680	Dep.; $0.50(OTS)
7736	17-12587	Dep.; $0.50(OTS)
7849	17-13297	Dep.; $1.00(OTS)
8036	17-12363	Dep.; $1.00(OTS)
NAA-SR-Memo–		
6584	17-12629	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NASA-SP–	**(Non-AEC)**	
11(Vol.2)	17-13851	$3.00(GPO)
NASA-TN–	**(Misc.)**	
D-1551*	17-13619	$0.75(OTS)
D-1560*	17-13813	$1.25(OTS)
D-1679*	17-13298	$0.75(OTS)
D-1696*	17-13299	$0.50(OTS)
NBL–		

Report No.	Abstract No.	Availability
188	17-12182	Dep.; $2.25(OTS)
HBS–	**(Misc.)**	
7644	17-13620	Dep.(mc); $1.10(fs), $0.80(mf) OTS
HDL-TR–	**(Non-AEC)**	
40	17-13488	
HLCO–		
865	17-12060	Dep.; $1.25(OTS)
HMI–	**(Misc.)**	
9249*	17-12588	
HP–	**(AEC File No. for Non-AEC Reports)**	
12394	17-12364	Dep.(mc); $5.60(fs), $1.97(mf) OTS
12421	17-12066	Dep.(mc)
12431	17-12495	
12463	17-12496	
12476	17-13780	Dep.(mc); $18.00(fs), $8.66(mf) OTS
12500	17-12760	
12501	17-12720	
12512	17-13814	Dep.(mc); $12.00(fs), $5.30(mf) OTS
12514	17-13351	Dep.(mc)
12517	17-13621	$5.60(OTS)
12518	17-13622	$4.60(OTS)
12519	17-13489	$1.60(OTS)
12521	17-12630	Dep.(mc)
12523	17-13623	
12539	17-12631	
12540	17-12497	Dep.(mc)
12541	17-13846	
12542	17-13624	
12543	17-12589	
HP-tr–	**(AEC File No. for Non-AEC Translations)**	
943	17-12455	Dep.(mc); $4.60(fs), $1.61(mf) JCL
HRC–	**(Canadian)**	
7113	17-12241	Can. J. Phys. 41: 209-19(1963)
HRL–	**(Misc.)**	
5874*	17-12668	$1.10(OTS)
HYO–		
7987	17-12324	Dep.(mc); $3.60(fs), $1.37(mf) OTS
9657	17-13470	Dep.; $4.00(OTS)
9813	17-12761	Dep.(mc); $2.60(fs), $0.89(mf) OTS
9852	17-12519	Dep.; $1.25(OTS)
10215	17-12632	Dep.(mc); $3.60(fs), $1.28(mf) OTS
10242	17-13352	Dep.(mc); $6.60(fs), $2.03(mf) OTS
10252	17-13490	Dep.(mc); $2.60(fs), $0.98(mf) OTS
10253	17-12762	Dep.(mc); $2.60(fs), $1.07(mf) OTS
10306	17-12337	See RRL-85
10309	17-12336	See RRL-88
10310	17-12341	See RRL-91
10314	17-12325	See RRL-100
10393	17-12453	Dep.(mc); $1.60(fs), $0.80(mf) OTS
OEL-NUCLEAR	**(Canadian)**	
56	17-12721	Dep.; $1.00(AECL)
ORNL–		
3353	17-13781	Dep.; $4.50(OTS)
3360	17-12763	Dep.; $4.00(OTS)
3375	17-12183	Dep.; $1.50(OTS)
ORNL-TM–		
464	17-12365	Dep.(mc); $1.10(fs), $0.80(mf) OTS
ORO–		
570	17-12138	Am. Naturalist 96: 309-15(1962)
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
882,361	17-13742	
902,207	17-13743	
903,012	17-13801	
903,418	17-13744	
904,889	17-12643	
905,220	17-12400	
905,919	17-12304	
906,020	17-12361	
907,634	17-12401	
912,710	17-12438	
914,004	17-12352	
914,807	17-12402	
915,503	17-12644	
915,506	17-12381	
915,627	17-12439	
915,633	17-12403	
915,652	17-12645	
915,693	17-12605	
915,717	17-12404	
915,747	17-12440	
915,748	17-12405	
915,773	17-13802	
915,807	17-13745	
915,808	17-13746	
915,861	17-12353	
915,888	17-12305	
915,981	17-12574	
916,144	17-13747	
916,150	17-12406	
916,176	17-13748	
916,190	17-12625	
916,199	17-13749	
916,201	17-13750	
916,212	17-12306	
916,217	17-12354	
916,222	17-13751	
916,227	17-13752	
916,253	17-13753	
916,322	17-13875	
916,324	17-13754	
916,325	17-13755	
916,326	17-13803	
916,331	17-13664	
916,550	17-12307	
916,608	17-12646	
916,618	17-12647	
916,703	17-13268	
916,770	17-12575	
916,820	17-13756	
916,821	17-13757	
916,871	17-13758	
916,893	17-13806	
916,895	17-13759	
916,980	17-13760	
916,994	17-12547	
916,999	17-12321	
917,015	17-12648	
917,097	17-12649	
917,111	17-12449	
917,137	17-12407	
917,195	17-12576	
917,238	17-12577	
917,402	17-12382	
917,414	17-12441	
917,461	17-13761	
917,545	17-12408	
917,606	17-13804	
917,613	17-12442	

Report No.	Abstract No.	Availability
917,649	17-12650	
917,685	17-12489	
917,712	17-12443	
917,776	17-12222	
917,809	17-13762	
917,820	17-12190	
917,839	17-12548	
917,878	17-12409	
917,937	17-13763	
918,044	17-12651	
918,061	17-12549	
918,097	17-12444	
918,098	17-12445	
918,161	17-12410	
918,183	17-12411	
918,187	17-12191	
918,224	17-13764	
918,230	17-12412	
918,237	17-12606	
918,246	17-12446	
918,303	17-12383	
918,304	17-12384	
918,305	17-12385	
918,374	17-12308	
918,536	17-13765	
918,537	17-13766	
918,564	17-12550	
918,644	17-13767	
918,677	17-12413	
918,678	17-12414	
918,697	17-12415	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,036,674	17-12416	
3,043,323	17-12417	
3,061,533	17-13768	
3,077,113	17-12418	
3,077,361	17-12419	
3,077,378	17-12386	
3,077,443	17-13769	
3,077,445	17-13770	
3,077,452	17-12420	
3,077,505	17-12551	
3,077,712	17-12421	
3,078,551	17-12652	
3,079,136	17-12607	
3,079,179	17-12422	
3,079,225	17-12355	
3,079,251	17-12653	
3,079,317	17-12356	
3,079,321	17-13771	
3,079,323	17-12423	
3,081,068	17-12424	
3,081,237	17-12608	
3,081,619	17-12552	
3,082,163	17-12654	
PATENTS	**(U.S.S.R.)**	
144,559 (685,696/26)	17-12535	For translation see FTD-TT-62-1529
PIBMRI–	**(Non-AEC)**	
970-61	17-13625	$5.60(OTS)
PR-P–	**(Canadian)**	
55	17-12802	Dep.; $2.00(AECL)
PRDC-TR–		
61	17-13681	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RAD-SR–	**(Non-AEC)**	
63-29	17-12669	
RADC-TDR–	**(Misc.)**	
62-172*	17-12803	
62-352*	17-13626	$9.10(OTS)
RAI–		
104	17-12366	Dep.(mc); $10.10(fs), $3.83(mf) OTS
RFP–		
297	17-12582	Dep.; $0.50(OTS)
RISÖ–	**(Danish)**	
45	17-12454	Dep.(mc)
51	17-12498	Dep.(mc)
54	17-13627	Dep.(mc)
RM–	**(Misc.)**	
2936-ARPA*	17-13353	
RRL–	**(Misc.)**	
85	17-12337	J. Chem. Phys. 38: 4-7(1963)
88	17-12336	J. Chem. Phys. 38: 1-3(1963)
91	17-12341	J. Chem. Phys. 38: 773-4(1963)
100	17-12325	Dep.(mc); $1.60(fs), $0.80(mf) OTS
101	17-12804	Dep.(mc); $3.60(fs), $1.31(mf) OTS
RT-FI–	**(Italian)**	
(62)-57	17-13471	Dep.(mc)
RT-GEN–	**(Italian)**	
(62)2	17-13786	Comit. Nazl. Energia Nucl. Notiziario 8: 3-10(1962)
SCDC–		
2985	17-12670	See TID-17915
3045	17-12723	See TID-17933
SCL-T–		
462	17-12185	Dep.(mc); $3.60(fs), $1.40(mf) JCL
SCPRI(T)–	**(French)**	
80	17-12499	Dep.(mc)
SCTM–		
134-62(72)	17-12530	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SM–	**(Misc.)**	
36/86	17-12722	See TID-17839
SP–	**(Non-AEC)**	
620-101-62U	17-12760	See NP-12500
STI-Pub.–	**(International Atomic Energy Agency)**	
59(Vol.II)	17-12615	$11.00(IAEA)
TEES–		
2671-2	17-12193	Dep.; $5.50(OTS)
TID–		
3574	17-13682	Dep.; $0.50(OTS)
8213	17-12590	Dep.; $1.00(OTS)
15508	17-12124	Dep.(mc); $1.60(fs), $0.80(mf) OTS
15755	17-12125	Dep.(mc); $1.10(fs), $0.80(mf) OTS
15762	17-12226	Dep.(mc); $2.60(fs), $0.83(mf) OTS
15840	17-12126	Dep.(mc); $2.60(fs), $0.92(mf) OTS
15940	17-12556	Dep.(mc); $1.60(fs), $0.80(mf) OTS
15950	17-12127	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16047	17-12081	Am. J. Med. 33: 188-200(1962)
16090	17-12194	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16171	17-13691	Atomics 16: 24-5(1963)

Report No.	Abstract No.	Availability
16192	17-12227	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16242	17-12228	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16248	17-12128	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16249	17-12129	Dep.(mc); $2.60(fs), $0.95(mf) OTS
16262	17-13572	Phys. Rev. 129: 2113-16(1963)
16276	17-12333	J. Am. Chem. Soc. 84: 4627-33(1962)
16519	17-12268	J. Phys. Chem. 67: 339-45(1963)
16865	17-13168	Proc. Roy. Soc. (London), Ser. A, 271: 243-67(1963)
16896	17-12312	J. Am. Chem. Soc. 85: 294-7(1963)
16927	17-13432	Phys. Rev. 129: 2280-5(1963)
16931	17-12256	J. Chem. Phys. 38: 270-1(1963)
17008	17-12229	Dep.(mc); $2.60(fs), $1.07(mf) OTS
17096	17-12310	J. Am. Chem. Soc. 85: 8-14(1963)
17508	17-12326	Dep.; $1.00(OTS)
17541	17-12100	Dep.(mc); $2.60(fs), $0.89(mf) OTS
17638	17-12230	Dep.(mc); $1.60(fs), $0.85(mf) OTS
17812	17-12447	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17814	17-12231	Dep.(mc); $2.60(fs), $0.83(mf) OTS
17819	17-12130	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17820	17-12131	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17828	17-12232	Dep.(mc); $4.60(fs), $1.52(mf) OTS
17830	17-12394	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17831	17-12425	Dep.(mc); $2.60(fs), $0.83(mf) OTS
17835	17-13615	Dep.(mc); $6.60(fs), $2.15(mf) OTS
17839	17-12722	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17840	17-12132	Dep.(mc); $2.60(fs), $0.83(mf) OTS
17842	17-12367	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17861	17-12611	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17862	17-12633	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17869	17-12247	J. Am. Chem. Soc. 85: 240(1963)
17888	17-13628	Dep.(mc); $2.60(fs), $0.92(mf) OTS
17892	17-12133	Dep.(mc); $3.60(fs), $1.22(mf) OTS
17903(and Add.1)	17-12184	Dep.(mc); $4.60(fs), $1.67(mf) OTS
17912	17-12591	Dep.(mc); $2.60(fs), $1.07(mf) OTS
17915	17-12670	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17933	17-12723	Dep.(mc); $3.60(fs), $1.22(mf) OTS
TIL-T–	**(British)**	
5278	17-13629	
UAC–		
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6657	17-13168	See TID-16865
6676	17-12312	See TID-16896
7005	17-12447	See TID-17812
7018	17-12425	See TID-17831
7022	17-12711	See ANL-FGF-399
7026	17-12722	See TID-17839
7037	17-12367	See TID-17842
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